The American Journal of Surgery

NEW SERIES, VOL. XXI SEPTEMBER, 1933 No. 3

THE ABDUCTION METHOD

CONSIDERED AS THE EXPONENT OF A TREATMENT FOR ALL FORMS OF FRACTURE AT THE HIP IN ACCORD WITH SURGICAL PRINCIPLES

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FOR many years I have been engaged in demonstrating the observation that "only by varied iteration can alien conceptions be forced upon reluctant minds," in this instance the alien conception being that the treatment of fracture of the neck of the femur should be in accord with that of other fractures.

This is, or was, an alien conception because the entire structure of conventional teaching and practice is based on the inadequacy of the means at command to apply these principles effectively.

This inadequacy was so clearly demonstrated by Sir Astley Cooper, early in the last century, that he succeeded in establishing legal immunity for the result on the ground that positive treatment was both hazardous and futile. It was hazardous because the typical patient was aged and infirm and because an impaction, the only assurance of apposition, "might be broken up." It was futile because of the very doubtful capacity of the tissues for repair. His teaching is summarized in a modern treatise on fractures in the statement that "The ideal object of treatment, restoration of form and function, is rarely to be attempted or even sought,"[1] and more specifically in a textbook published recently: "The patient should be propped up in bed with the limb between sandbags. After about a month the patient should be encouraged to use the limb as much as possible as union is not aimed at."[2]

Sir Astley Cooper's conclusions referred to the intracapsular or "true" fracture, but since there was until comparatively recent times no means of distinguishing types, the treatment in quality was alike for all. At best it was symptomatic in intention and perfunctory in application, "limited to making only so much reduction of the shortening as can be expected by moderate traction and to immobilization by traction or by cushions or by a fixed dressing."[3]

Both to the professional and lay mind, a broken hip implied immediate danger and irreparable disability.

> Our prognosis must always be unfavorable. In many instances the injury soon proves fatal and in all, the functions of the limb are forever impaired. No matter whether the fracture has taken place within or external to the capsule, whether it has united by ligament or bone, shortening of the limb and lameness are the inevitable results.[4]

This conclusion of a Victorian authority is amply supported by present-day statistics.

Of 169 medial fractures reported by Katzenstein of Berlin in 1928, good results were attained in but 11.6 per cent,

a percentage which, according to Axhausen, fairly represents the usual experience.[5] Of 136 cases treated at the Charity Hospital of Berlin, reported by Hübner in 1930, union was attained in but 6 per cent. Of 86 cases of fracture at the hip, irrespective of type, tabulated by the British Committee, good anatomical and functional results were attained in but 16.5 per cent of the number.[6]

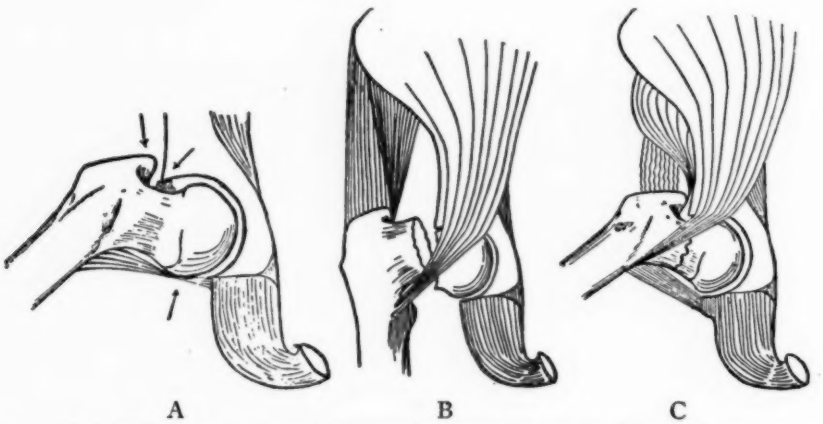

FIG. 1. Original diagrams (1902) illustrating mechanism of abduction treatment.
A. Range of normal abduction limited by contact of bone and by tension on capsule.
B. Fracture and displacement illustrating muscular action.
C. Reduction by abduction method illustrating bony contact and muscular impotence.

The inception of the abduction treatment, the basis of the alien conception and therefore the exponent of radical reform, dates from the identification of fracture of the neck of the femur in a child in 1890. The observation of this and similar cases for a period of years demonstrated clearly the disabling effect of the characteristic deformity, afterward called coxa vara, on the function of the limb.

This study led eventually to the evolution of an effective method for restoring and maintaining the normal relation of the injured joint by substituting natural for artificial mechanics. (Fig. 1.) The new treatment had the great advantage that it was tested in a class of cases in which there was no question of danger to the patient. Nor of capacity for repair. When, however, it was proposed to apply the same principles in the treatment of the fracture in the adult, one came into direct opposition with authority.

The technical effectiveness of the anatomical method could hardly be questioned since it might be readily demonstrated on the cadaver, at open operation and by *x*-ray examination after its application. (Fig. 2.) On such a background of failure, it might seem that a treatment offering such a reasonable prospect of improvement as a demonstrable opportunity for repair, would receive favorable consideration. On the contrary, there was no standard to which efficiency might appeal. Thus, to obtain an official hearing one must first prove by actual results that effective treatment of the fracture would not endanger both life and limb.

The abduction method had the further disadvantage, as an appeal to adventurous spirits, that it called for a much higher quality of technical preparedness than had ever been at the command of this neglected injury.

With the lapse of years, however, in spite of opposition and inertia, it has come into general use, and although it has been undertaken by novices, often with notable variations from the original, the results attained are quite out of comparison with any previously reported. (Fig. 3.) In 1927 Löfberg reported on 176 cases of

medial fracture treated by the abduction method, with union and good function in 67.5 per cent.[7] The lowest percentage of union recorded, 53.8 per cent, is that of a committee of the American Orthopaedic Association from a number of clinics at which the treatment "was applied either in detail or principle."[8]

Henderson, from the Mayo Clinic, has reported on 42 cases with union in 90 per cent of patients under sixty and 65 per cent of those over that age.[9]

The most recent and perhaps the most representative report since the patients were of the hospital class is that of Stern and his associates at Cleveland. Of 77 cases of medial fracture, union was attained in 67 per cent. It may be noted as illustrative of the comprehensive practicability of the treatment that 28 of the patients were between sixty and seventy with union in 68 per cent, and 17 were over seventy with union in 78.5 per cent. Yet the mortality was but 7 per cent.[10]

The anatomical method by which apposition of the fragments within the capsule is assured is equally effective in correcting the characteristic deformity at the base. This procedure, far from endangering repair, by apposing the fractured surfaces, hastens it and checks the exuberant callus formation, often noted as a common accompaniment of this type of fracture.

Thus it will appear that "restoration of form and function" has now become a practicable routine of treatment for all fractures at the hip.

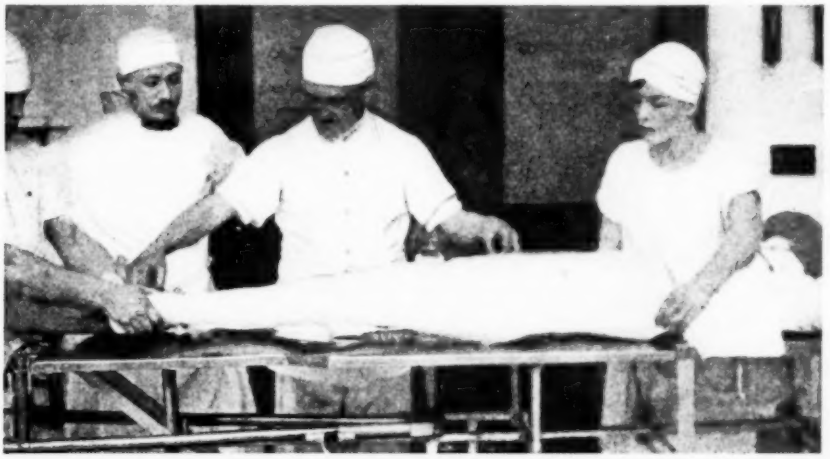

Fig. 2. First step in abduction treatment. Shortening is reduced by direct manual traction and verified by measurement, limb having been rotated slightly inward as indicated by position of patella.

If, therefore, those at the base, where union is assured, are approximately equal in number to those of the small part of the neck, one may fairly count on favorable results from the functional standpoint in 80 per cent of the cases in which the treatment is properly applied and carried to a conclusion. This implies protection of the injured part until consolidation is complete and until muscular control is established, an essential supplement to initial efficiency, which in the past has been equally neglected. (Fig. 4.)

The relative efficiency of the anatomical method must be evident to anyone capable of mechanical analysis. And since its practicability as regards the patient and its effectiveness as a treatment of the fracture have now been amply demonstrated, one must conclude with Mosenthal that "the real obstacle to its general adoption is inability to meet its requirements."[11]

These immediate requirements are a clear conception of anatomical mechanics and topography, and the ability to construct a secure and comfortable plaster spica.

For although "restoration of form," the primary essential of functional repair, is attained by anatomical leverage and the Whitman spica, and in the very thin individual I am afraid to put it on." This surgeon sometimes applied the spica

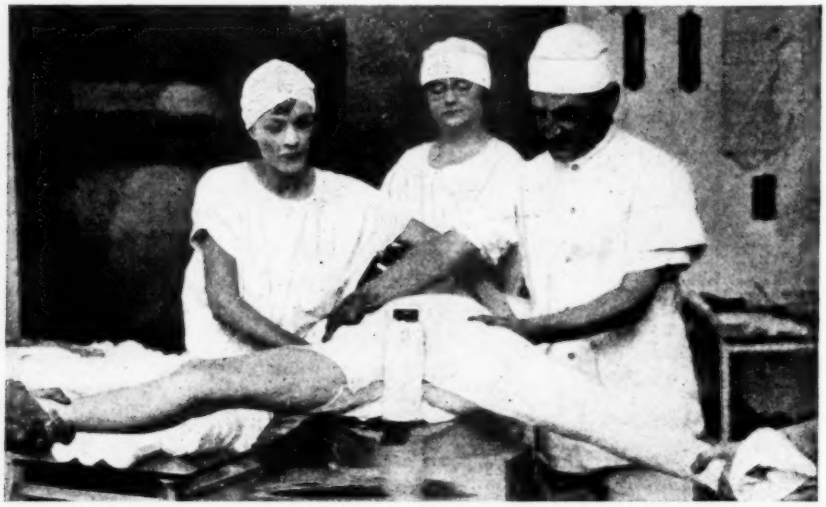

FIG. 3. Second step. Limbs, under manual traction, are abducted to normal limit as indicated by range on sound side, upon a level pelvis, surgeon verifying exact correspondence of anatomical landmarks on two sides.

Full abduction assures ligamentous tension, adjustment and mutual pressure of fragments, approximation of trochanter and pelvis, and complete muscular impotence. Full extension maintains normal lumbar lordosis and assures additional support from spica against backward displacement of outer fragment. Slight inward rotation turns outer fragment away from capsule and prevents its interposition.

splinting, its maintenance requires that the limb be supported in a definite relation to the trunk, namely, in full extension, full abduction and slight inward rotation. For this purpose the plaster spica is the only support at command, and in this sense it may be accepted as an integral part of the abduction treatment. It presents an obtrusive demonstration of positive treatment of the fracture as contrasted with "life-saving neglect." It is furthermore the "requirement" that most directly concerns the patient, and therefore the most searching test of the technical training and experience of the surgeon. Consequently it has borne the brunt of the adverse criticism of the abduction treatment.

This point is illustrated in a discussion at a recent meeting of a committee on fractures of the American College of Surgeons. One speaker stated that he reserved the abduction treatment for selected cases, "for when your patient has a fat, flabby belly you cannot put on in flexion, incorporating in it a kitchen chair to enforce the sitting posture. I am sure that one trained and experienced in this treatment would disregard these restrictions and would look on the flexed spica as a manifestation of the influence of the tradition that rest in bed and particularly the extended attitude endangered life in elderly patients.

Under the old conditions enforced dorsal recumbency was dangerous because of bed sores and hypostatic congestion, complications which the plaster spica, permitting alternation of posture, has in great degree eliminated. In fact it has long since been demonstrated that effective treatment of the fracture by this method is the most conservative treatment of the patient even in old age, as instanced by Stern's statistics. (Fig. 5.)

To another member, the abduction treatment was unsatisfactory because "you do not know what is to happen. For, after perfect reduction when the spica is removed, it is not uncommon to find that

the neck may have entirely disappeared." It may be noted as an indication of progress that the treatment is criticised because it permits early movement which, as in the treatment of other joint fractures, should stimulate repair.

Fig. 4. Head of bed is elevated to enable patient to dispense with pillows. At intervals posture is changed, patient often passing as much time in ventral as in dorsal position, thus preventing bed sores and hypostatic congestion.

Long spica is always used, leverage of limb being balanced by trunk portion. This has great advantage that patient may be more easily turned and that sound limb is not constrained. Spica is slightly flexed at knee to lessen strain. Foot is fixed at right angle in slight adduction.

Fitted shirting prevents wrinkling, and, as chief purpose of spica is to support limb rather than to splint fracture, a thick covering of sheet wadding and bandage is applied beneath plaster in order to assure a soft and even contact.

the outcome is uncertain, whereas formerly, the possibility of repair was considered debatable and its attainment so remote a prospect as hardly to merit the attempt to promote it. The speaker attributes this disintegration to defective circulation and concludes that "immobilisation is not going to improve this, that some sort of treatment to provide circulation and granulation tissue at the site of fracture would seem to be in order . . . and this may be the mechanism of the Smith-Petersen operation." He does not suggest an explanation as to how a nail driven through the cancellous tissue with the purpose of assuring more complete fixation can accomplish this result.

Both speakers favored traction in suspension as an alternative to the abduction treatment. One because he "finds it easier to get good nursing," the other because

Fig. 5. Taken through plaster at a later time, showing security of fixation and progress of repair.

The picturesque complexity of the various forms of traction, as contrasted with more direct and prosaic methods, makes a special appeal to the medical imagination, which in this instance at least is not supported by the evidence.

Traction has been the basis of conventional treatment for time out of mind. Many years ago Wilson investigated the final functional results in 18 cases treated by this method at the Philadelphia Hospital, two-thirds of the fractures being intracapsular. Five of the patients had never attempted to walk, 8 used two crutches, one, a crutch and cane, one, two canes. Two used one cane, one, a high shoe without a cane.[12]

Traction in suspension and multiple traction[13–15] were at the disposal of the profession long before the abduction method was devised and doubtless when skillfully applied and constantly supervised the percentage of repair might be materially increased.

The method, however, is fundamentally defective, for since the neck of the femur projects laterally from the shaft, traction can at best appose the fragments only in a lateral and therefore unstable relation, whereas the security essential to interstitial repair can be maintained only by the end-to-end apposition and mutual pressure of

the fractured surfaces. This point is illustrated by Waldenström,[16] who contrasts two groups of cases, in one of which he at-

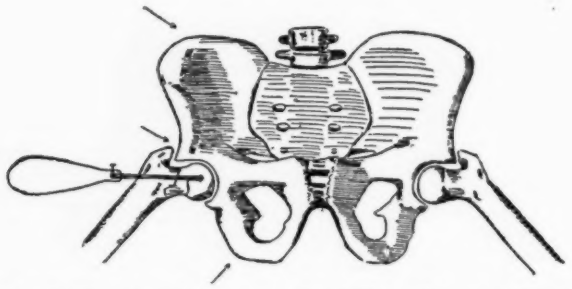

Fig. 6. Fixation of fragments by drill used as an adjunct to abduction treatment.

tempted to apply the principles of the abduction treatment by multiple traction. Union was attained in 13 per cent as contrasted with 50 per cent of those in which the plaster spica was applied. In explanation of the disparity he cites the experiments of Rhode, which indicate that even slight movement of the fragments will prevent endosteal repair.

The other alternative mentioned in the discussion is the Smith-Petersen open operation. It is claimed for this procedure, as compared to the abduction treatment, that visual fixation of the fragments will greatly increase the percentage of repair. Smith-Petersen,[17] the foremost exponent of the procedure, has recorded final results of 17 operations. There were 3 deaths and 3 failures. If a case in which union was established at autopsy be included, the result was satisfactory in 70 per cent. Two of the deaths were attributed to infection, which is evidently a danger to be reckoned with even under the most favorable conditions.

Subcutaneous spiking as a routine measure was introduced by Nicolaysen on the ground that it was the only means of maintaining apposition of the fragments, an assumption no longer tenable.[18]

A similar method in which a screw was substituted for the nail has been thoroughly tested by Delbet, who has reported on 35 cases with union in 4 (13 per cent).

Recently a more effective form of subcutaneous spiking has been described by Johansson,[19] and Wescott,[20] the procedures being practically identical. The Smith-Petersen flanged nail is used. The fracture is reduced by the abduction method, and the nail following a guide is driven in under *x*-ray observation, thus assuring accurate adjustment.

The method of inserting the nail after the fragments have been apposed by the abduction method, as employed by Johansson and Wescott, and recently by Jones,[21] is far more accurate and effective than that of Nicolaysen or Delbet.

It may be of interest to note, therefore, that for a short time many years ago, I employed the same procedure in a simpler form, a drill being inserted as shown in the accompanying figure (Fig. 6). The object was to assure greater immediate security. It was soon discarded as unnecessary and particularly because the drill was always loose when the spica was removed.

It is claimed that the flanged nail assures immediate security without external support and that the period of disability is materially shortened. This is doubtful since ultimate resistance must depend on reconstruction of the bony structure, a process which should be retarded by injury to the cancellous tissue caused by insertion of the nail. In fact depression of the neck, due to breaking of the bone graft or displacement of the metal pin, is a common sequel of operations of this type.

Johansson reports on 9 operations, the first on January 16, 1932 and the last on August 30, 1932. In but 3 cases, therefore, had sufficient time elapsed to estimate the result and in one of these there was evident failure of repair.

Wescott reports on 3 operations, the first in February, 1932, the last in April, the paper being published in July. Apparently the results were considered satisfactory in 2 of the cases.

Although the operative technique of the two surgeons was similar, the after treatment was different. Johansson enforced

rest in bed for many weeks and permitted locomotion only with great caution. Wescott by contrast concludes "that external fixation is eliminated," that "the patient after a few hours is ready for a wheel chair, or if so disposed, may at once enjoy the use of crutches."

Fig. 7. Smith-Petersen nail immediately after insertion.

Fig. 8. Seven months later, showing disintegration and separation of fragments and depression of head, indicating instability.

I think it must be admitted that resistant repair of a medial fracture requires many months for its accomplishment. It may be doubted, therefore, if the period of locomotive disability can be materially shortened by any form of operative intervention. Furthermore, even if it be admitted that the nail will serve as an independent support during the period of repair, the advantage as regards the patient is counterbalanced as regards the fracture by the very definite objection to all operations of this type, namely, that a certain disintegration of the extremity of the distal fragment is not unusual. This may not prevent repair in cases treated by the abduction method because apposition is maintained. If, however, a peg had been inserted, the fragments would be actually separated by the means designed to appose them, as is illustrated in one of Johansson's *x*-ray pictures.

It seems evident that the flanged nail assures greater immediate security than any other form of peg, and as far as one may judge from the *x*-ray pictures presented by Johansson and Wescott, the adjustment is as satisfactory as in those shown by Smith-Petersen.

For those who favor the primary operation, it would seem that the subcutaneous method has such obvious advantages in practicability and safety that the open operation should be reserved for ununited fractures. (Figs. 7 and 8.)

It may be noted in this connection that formerly the argument for the immediate operation had a much more logical basis than at present.

Thirty years ago Bissell, a well-known surgeon, from a personal investigation of the treatment of the fracture in three leading hospitals in New York concluded that it assured neither coaptation nor fixation of the fragments: "Since the treatment was supervised by sixteen well-known surgeons, many of them eminent teachers" it might be accepted as representative. He concluded therefore "that only the open operation could hold out a hope to a class of patients, the vast majority of whom medical literature and opinion have given up as hopeless."[22]

Assuming that the purpose of the Committee is to formulate principles of treatment and to indicate the most practicable and effective means of applying them to the average patient and for the average

fracture, the discussion in this instance is not enlightening.

The average patient may be represented by 120 consecutive cases of ununited fracture at the hip recorded at the Mayo Clinic, "not one of which had received efficient treatment at the time of injury."[23]

For the average patient and for the average fracture in a comprehensive sense, there can be no alternative for the abduction treatment. Nor for the average patient can there be any alternative for the plaster spica, because it is the only available support.

Actually, the plaster spica, in competent hands, since it relieves the pain and permits changes of posture has not only extended the range of positive treatment of the fracture far beyond the former limits, but has materially reduced the death rate, thus demonstrating that in this as in other fractures, effective treatment of the broken bone is the most conservative treatment of the patient.

The abduction treatment may be supplemented by any means internal or external "that may improve the circulation or stimulate the formation of granulation tissue." It may be modified on occasion, but as a basic treatment it can never be supplanted.

It is characteristic of this as of other discussions that it is concerned only with the treatment of the medial fracture, as if this were the only type of injury at the hip joint worthy of consideration.

It may be noted also that certain surgeons who feel constrained to utilize the abduction method when the question of union is involved, revert to traction in the treatment of extracapsular fractures, where the primary question is of function, ostensibly in the interest of the patient. Actually the abduction method bears the same relation to other methods in effectiveness for fractures at the base as for those within the capsule, since this is the only means by which deformity, even if resistant, may be easily and definitely corrected.

It will appear that the term "average patient" has now a new significance. Under the old conditions the average patient as represented in the textbooks was an aged and feeble individual with the type of fracture that would justify immediate neglect and anticipated failure. "If I had a mother who were to have a fracture of the neck of the thigh bone, I would say 'Make her as comfortable as you can and let her go without further consideration.' "

Now, however, the term is comprehensive in its application as regards the patient, including a class of cases unknown to those who formulated the rules of practice, namely, the fracture in childhood and epiphyseal displacement in adolescence. It includes also all types of fracture in adult life with an indefinite extension to old age.

The abduction treatment as the exponent of the positive standard, in this comprehensive sense, may be supplemented by any procedure required for the restoration of form and function.

Thus the neglected fracture in childhood results in so-called traumatic coxa vara, the neck being depressed and turned backward in its relation to the shaft. The correction of this deformity requires an osteotomy at the base of the neck to permit the restoration of the normal relation by abduction and inward rotation of the limb.

In epiphyseal fractures the head is displaced downward and backward on the neck. If seen in the progressive stage the normal relation may be restored by leverage on the acetabular rim as the limb is abducted and rotated inward to the required degree.

If, however, consolidation is advanced, an open operation for disengaging the fragments will be required, after which they are adjusted and fixed by the ordinary manipulation of the abduction method.

According to statistics from a variety of sources, union of the medial fracture is attained in approximately 65 per cent of the cases treated by the abduction method.

Of the remaining 35 per cent, judging from the reports and from personal observation, a fair proportion may be attributed to defectve treatment, but in a substantial remainder failure must be attributed to incapacity for repair. In the first instance the open operation would be indicated and in the second, in which the neck has "entirely disappeared," the reconstruction operation.

Effective treatment of the fracture has brought to light certain secondary and degenerative changes in the head of the femur that may be an occasional sequel of repair, whether attained by pegging or otherwise. In childhood and adolescence these seem to be caused by limited necrosis resembling that of the Legg-Perthes' disease,[24] in older subjects, somewhat akin to degenerative osteoarthritis. These changes, which are apparently explained by defective nutrition, may follow fracture at the base as well as those within the capsule.

If the disability warrants surgical intervention, the reconstruction operation would be indicated. The distorted head is removed, the neck moulded into a rounded extremity and the trochanter with the attached muscles is transplanted to the shaft, to restore normal muscular leverage.

Thus it will appear that fracture of the neck of the femur in all its forms and phases is now definitely under surgical control. Furthermore, that the result, because of the very obstacles to success that have thus far justified neglect, is more directly determined by treatment in strict accord with surgical principles than is that of any other injury of its class.

An encouraging indication of progress toward the acceptance of this conclusion is the statement in a recent paper that "suits for malpractise for poor results in fractures are markedly on the increase and that my comments in the hands of an unscrupulous lawyer might unjustly cause much trouble to one or another of our profession."

It is true that for many years I have been attempting to establish the proposition, that fracture of the neck of the femur is amenable to the rules that govern the treatment of other fractures and entitled, therefore, to the same consideration and protection.

If in return it must share with them the danger of legal reprisal from which it is now exempt, it will still be in the most favored position, for the uncertainty of repair is so well established that one could be held responsible only for the initial opportunity on which it depends. Thus, an *x*-ray picture taken through the plaster spica should serve as a complete protection to the competent surgeon.

As we look backward on the long campaign to extricate these unfortunate patients from the slough of despond, one change is very evident. At the outset there was no interest whatever in an injury in which the futility of treatment had been so clearly established both by scientific investigation and by practical experience. Now, according to Johansson, "scarcely any fracture has attracted so much interest or has been the subject of so much discussion as fracture of the neck of the femur." It is fair to assume that this interest indicates that what is called the consensus of opinion no longer supports the old teaching.

The present question at issue is not of the possible advantages that may justify primary spiking or bone grafting in a limited number of cases of a certain type; or whether traction or other appliances, although discredited by past experience, may not be so supplemented by skilled nursing as to be made relatively efficient.

The real question is of the standard which shall define the purpose of treatment of fracture at the hip in a comprehensive sense, and fix the responsibility for its attainment.

It seems evident that the peripheral pressure of comparative statistics must soon force the official establishment of a uniform standard.

In this event, one who proposes to undertake the treatment of the most disabling

of all fractures will doubtless qualify himself to meet the requirements of the treatment that has made the standard practicable, and I conclude from personal observations that one so qualified will find little occasion for substitutes.

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SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM

REVIEW OF 100 SYMPATHETIC GANGLIONECTOMIES*

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SURGERY of the sympathetic nervous system originated in the latter part of the nineteenth century largely as the result of Jonnesco's work. Before the war, Leriche's work on perivascular sympathectomy had aroused considerable interest. During the war the sympathetic system was practically forgotten from a surgical standpoint.

Royle is really the father of modern sympathetic surgery. Although his work on spasticities has not proved entirely successful, it initiated a wave of investigation and surgery out of which has grown a remarkably rational therapeutic surgical measure.

FIG. 1. Dorsal ganglionectomy. Showing common attachment of trapezius and rhomboids severed and muscles turned back as flap, exposing splenius muscle.

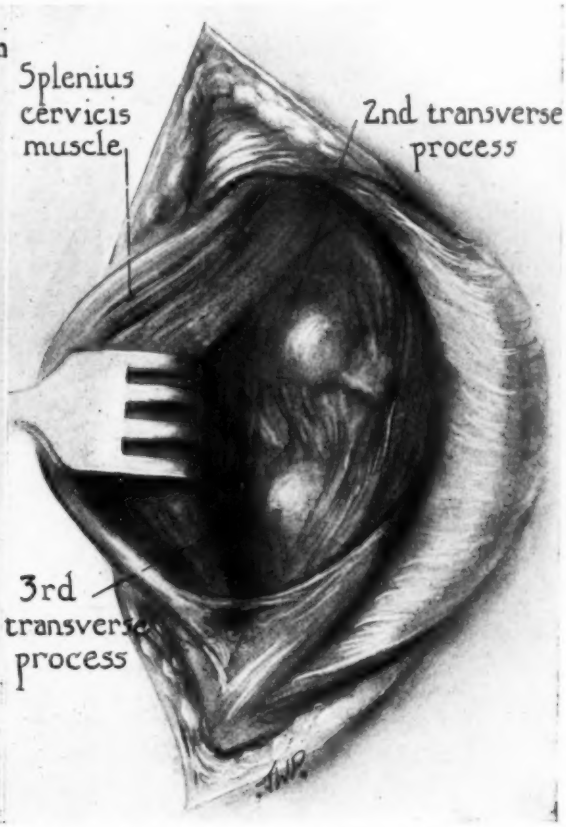

FIG. 2. Dorsal ganglionectomy. Splenius retracted medially exposing second rib and transverse process.

The history of sympathetic surgery since the impetus of Royle's work is most interesting. First came a wave of enthusiasm for the operation in spastic cases. After a comparatively short time the pendulum swung back and at present, most authorities feel that the operation in these cases

* Read at Pan American Medical Association Congress, Dallas, Texas, March 25, 1933.

is worthless, a feeling with which we do not agree. Then, initiated by Royle's observation of the increase in temperature of the affected extremities following sympathectomy, there arose a wave of enthusiasm for the operation in cases of vascular insufficiency of the extremities, both of the vasospastic and the obliterative types.

Owing to early results in Raynaud's disease the operation was hailed as a positive cure. During the height of this phase Lewis made the assertion that the disease was due entirely to a peripheral vascular reflex. This conflict of ideas still exists, but again the rational position is a conservative one in the midground.

Enthusiastic reports of results in Buerger's disease and allied conditions then appeared. These were soon followed by reports of numerous failures and again the pendulum swung too far to return to a level with the advent of diagnostic procedures for selection of suitable cases.

The next great wave was in the application of sympathetic surgery in cases of arthritis. At this point we entered the field with enthusiastic reports. Again the pendulum has swung and recently there is a noticeable absence of reports in the literature of sympathectomy for arthritis. Here again the pendulum has swung too far and is now ready to swing back.

The latest phase of the work has been in relation to pain. But now having become wary by reason of previous over-enthusiasm we are approaching the subject more slowly and rationally.

A very significant point in the whole picture which must be borne in mind is the fact that in no instance of any condition where over-enthusiasm was displayed has

Fig. 3. Dorsal ganglionectomy. Clearing second rib and transverse process showing exposed pleura.

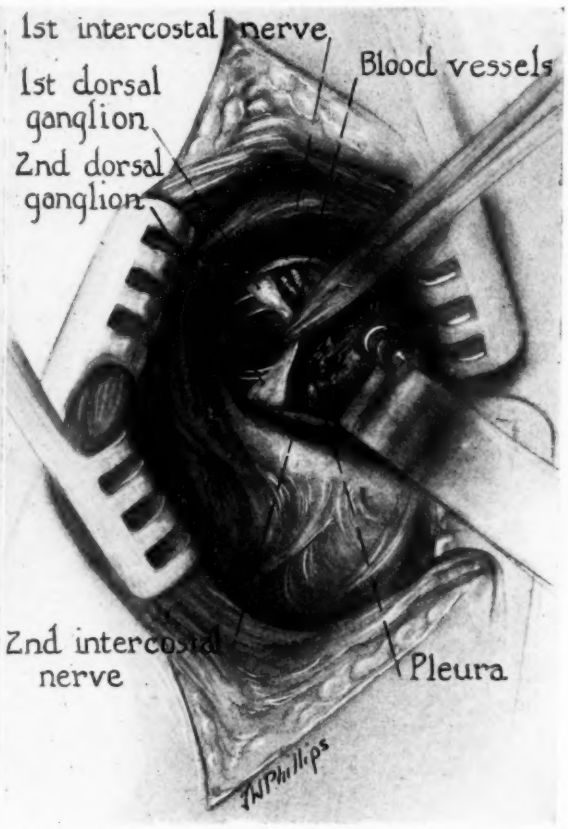

Fig. 4. Dorsal ganglionectomy. Portion of second rib and transverse process removed. Pleura retracted. Sympathetic trunk being cleared above and below. Showing blood vessels occasionally encountered.

there been a complete reversal to an admission of failure. Out of every wave has come a therapeutic measure which if properly evaluated and properly applied has become a valuable addition to our surgical armamentarium.

It is with the foregoing facts in mind that we are reporting the results of our first 100 sympathetic ganglionectomies. A large part of this work was done before the advent of reliable diagnostic procedures and we feel certain that with this experience behind us, the results of our future work will show a much higher percentage of success.

RAYNAUD'S DISEASE AND SCLERODERMA

We class these two conditions together since all of our cases of scleroderma show a large element of vasospasm, and a large percentage of our cases of Raynaud's disease show evidences of scleroderma if carefully examined.

In all we have done 23 operations on 10 patients. Eleven of the operations were for the lower extremity and 12 for the upper. Of the 10 patients, 3 were considered primarily scleroderma with a secondary element of vasospasm, and 2 cases were primarily vasospastic with secondary scleroderma. The other 5 patients had uncomplicated Raynaud's disease.

The 7 cases which were primarily Raynaud's disease have all been cured following operation. The scleroderma cases have not done as well and the postoperative improvement is slower. In each of the three, however, the improvement in skin mobility and in vascularity has been marked. Unfortunately they have been advanced cases of scleroderma; one patient practically a living cadaver, who died several months after the last operation, apparently as a result of the disease, affecting her visceral organs. Her skin and the circulation in the extremities had been markedly improved by operation. We feel that the earlier these cases are treated the better the prognosis. The ultimate prognosis is, however, not good since this is, no doubt, a metabolic disease affecting the entire body. Sympathectomy does not remove the cause, it merely ameliorates some of the results of the disease.

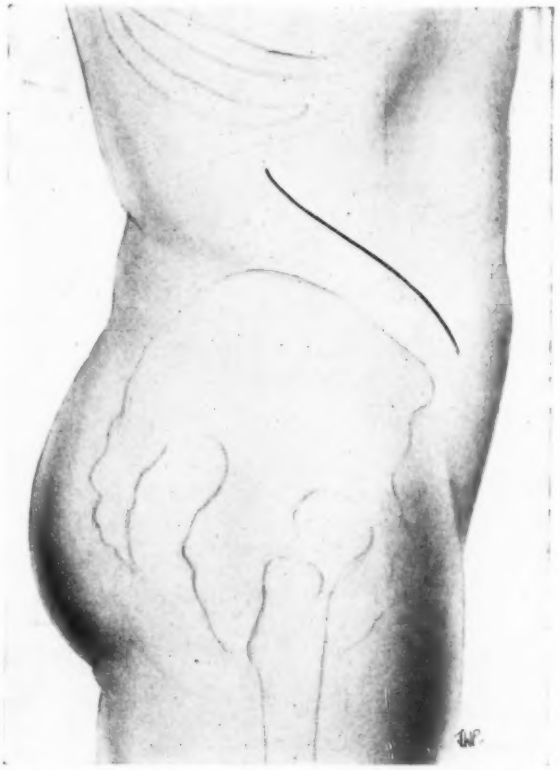

Fig. 5. Lumbar ganglionectomy. Line of incision.

It is worth noting that the results of sympathectomy in Raynaud's disease of the lower extremities is better than that for the uppers. Two of our patients and several patients of other men that we have seen still have a certain amount of vasospasm after dorsal sympathectomy. This, however, is not a source of discomfort and is apparently of no consequence. It is no doubt due either to regeneration of sympathetic nerves or to incomplete denervation. Since we do not see this phenomenon after lumbar ganglionectomy, we feel that the latter explanation is the more likely.

THROMBOANGIITIS OBLITERANS (BUERGER'S DISEASE)

The results in this disease are remarkably good when one considers the pathology. Success is dependent, however, on properly selecting suitable cases. Operability is

dependent upon the degree of vasospasm present. Where the lesion is entirely obliterative, operation obviously cannot be of benefit except for its possible effect on collateral circulation.

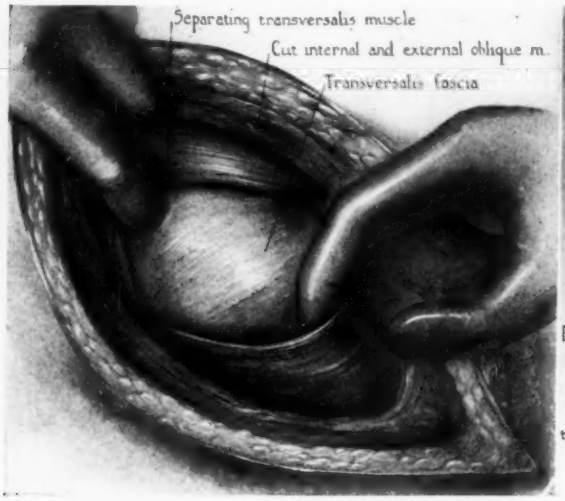

Fig. 6. Lumbar ganglionectomy. External and internal oblique muscles cut. Transversalis being separated in direction of its fibers.

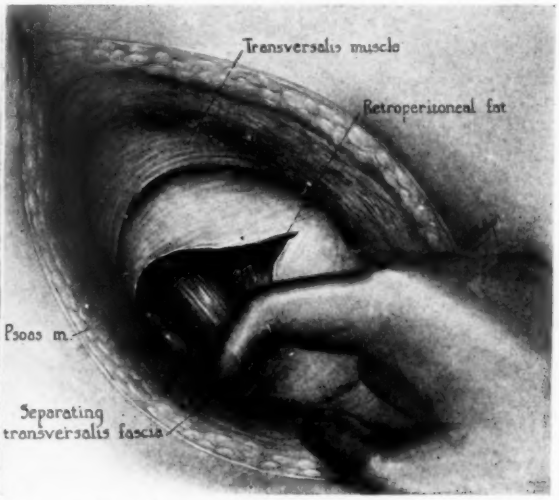

Fig. 7. Lumbar ganglionectomy. Transversalis fascia cut. Peritoneum pushed forward exposing psoas muscle.

Diagnostic injection of the sympathetics or spinal anesthesia accurately determines the question of operability. A good vascular index on the diagnostic text indicates almost certain success. A poor vascular index however does not always preclude improvement following sympathectomy.

We have done 13 operations, 9 lumbar and 4 dorsal, on 11 patients. The immediate results have been excellent in every case. Only one case has come to major amputation. This one was a borderline case with a large gangrenous area following amputation of the toe. This gangrenous area healed after operation and the result was apparently very good. We have recently heard, however, that amputation was done later. Two other patients have lost fingers or toes by amputation because of osteomyelitis; in each case the stump healed. There is one death in this series following transabdominal sympathectomy. We may say then that the results in 9 of the 11 cases have been excellent.

In this group are several in which diagnostic injections were not done, and several in which the tests did not give a very good vascular index.[1] Fortunately all of these turned out very well. Two cases in which operation was done at the request of the patient in spite of a poor prognosis were remarkably successful. This may be due to the fact that the possible effects on collateral circulation cannot be judged by a diagnostic procedure.

CHRONIC ARTHRITIS

Most of our early operations were done for this condition.[2,3] The results have not been all that we hoped for. There have been 23 operations on 10 patients, 15 lumbar and 8 dorsal. There was one death following the transabdominal operation. (This death and the one previously mentioned, both following the transabdominal approach, constitute the entire mortality from the lumbar operation. Since adopting the retroperitoneal approach we have done over 50 operations without a death.)

In 7 of the 10 patients the results have been well worth while, with relief of arthritic pain and improvement in joint function. Two of the patients obtained some relief of pain for a time but later had recurrence and are classed as failures. Both are women; the men have all done well.

Our attitude regarding arthritics is that where pain is the predominant symptom and a source of great discomfort it can usually be relieved by sympathectomy. Where joint changes are marked, however, little improvement can be expected, although in some cases considerable increase in mobility has occurred as the result of releasing the splinting muscle spasm by relieving the pain.

The optimum case is the young individual having cold clammy painful extremities with apparent vasomotor spasm. The suitable cases may be quite accurately selected from this group by choosing those in which diagnostic injection brings relief of pain and marked increase in temperature.

Sympathectomy for arthritis is one of the conditions in which the pendulum has swung too far both ways. Some cases are suitable and it is to be regretted that many of these unfortunates are denied the undoubted benefits of sympathectomy.

SPASTIC PARAPLEGIA

There have been 17 operations, 10 lumbar and 7 dorsal, on 9 patients. The results are classified as good in 6, fair in 4, and failures in 7. Most of the poor results were in cases of spasticity of the upper extremity. Of the 10 operations for the lower extremity, 6 were classified as good, 2 as fair, and 2 as failures. Of the 7 operations for the upper extremity, 2 are classed as fair and the other 5 as failures.

Of these cases 3 classified as good results really were excellent. All were intelligent youngsters with spasticity of the lower extremities. The improvement in these cases following ganglionectomy was really extraordinary.

In this group were 3 patients having spastic chorea of the upper extremities. The result in only one of these was good, this one showing a marked improvement in speech and moderate improvement in spasticity. The other 2 cases were failures.

One case was a spastic paralysis of both lower limbs and bladder, following a bullet wound of the spinal cord. The bladder function was markedly improved by the operation, the spasticity of the

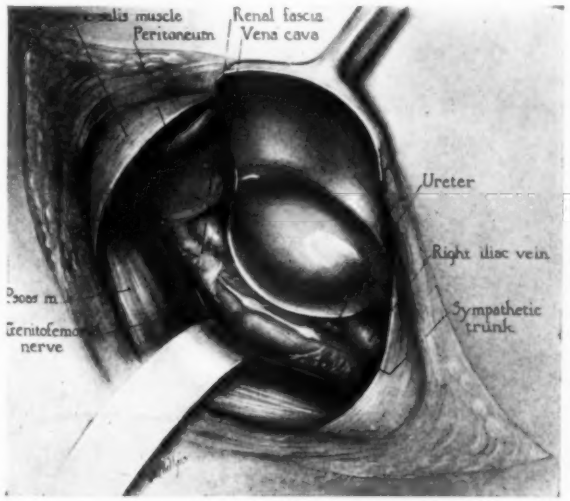

Fig. 8. Lumbar ganglionectomy. Abdominal contents retracted medially. Psoas retracted laterally. Renal fascia cut. Ureter and iliac vein retracted medially exposing sympathetic trunk.

limb was but slightly affected. This operation was done several years ago before Learmonth's work on cord bladders.

From the foregoing work we have come to definite conclusions. We feel that the pendulum has swung too far. The operation for spasticity is not a failure. Cases should be chosen only among normally intelligent children that are able to walk. Children that have never walked will probably not walk as a result of sympathectomy. Painstaking training and care which is unceasing must be given after operation.

The operation for spasticity of the upper extremity is so ineffectual as to be useless and we have given it up. For the lower extremities in selected cases it is well worth while.

MEGACOLON AND CHRONIC CONSTIPATION

We have had 3 cases of megacolon on whom left lumbar ganglionectomies have been done. In each of the three the result has been highly successful. Removal of the left lumbar chain including the first lumbar ganglion is indicated in

this disease and is apparently rarely unsuccessful in producing a functional cure.

We now venture into a field which will probably cause adverse comment; the treatment of chronic constipation in the adult by left lumbar ganglionectomy. In all of our previous work we had noted that patients who were constipated before operation were invariably relieved following left lumbar ganglionectomy. The physiologic basis of this result is clear. Sympathetic impulses cause sphincter spasm and act as inhibitors of the propulsive mechanism of the bowel. Following their removal, sphincter spasm is relieved and the motor propulsive mechanism is unopposed. On the basis of these observations and this physiology we base the indications for operation. Cases chosen are naturally only very severe ones in which the constipation is disabling or a definite threat to the patient's well-being. Furthermore, only those which do not respond to medical measures are deemed suitable.

As already noted, many patients in whom the operation was done for other conditions have been relieved of constipation.

The operation has been performed primarily for constipation in 5 adults. In each instance it has resulted in complete success and the establishment of normal bowel function in from four to six weeks after operation. Four of the 5 patients were epileptics in whom excessive uncontrollable constipation was apparently related to their seizures. The fact that these patients are on a rigidly restricted fluid intake increases their distress. While the operations were done primarily to relieve constipation, a surprisingly beneficial effect has been noted upon their general health and in a lessened severity and number of convulsive attacks. They also show a marked mental improvement.

We feel that the occasional case of severe disabling chronic constipation, not controlled by medical means, should have the benefit of physiologic release of the bowel by sympathectomy. The operation is apparently invariably successful and since it is practically without mortality and with no untoward after effects it seems to us that it is warranted in these cases.

TRAUMATIC SYMPATHALGIA (CAUSALGIA)

This describes a condition for which we have coined the foregoing descriptive term. This syndrome consists of a painful extremity, usually cold, subject to cyanotic changes when exposed to cold, often associated with increased perspiration, and frequently associated with a certain degree of non-pitting edema. Pain and diminished function of the parts are the primary complaints. Frequently cursory examination reveals nothing, but a more careful examination brings out the presence of slight cyanosis, increased perspiration, and slight edema which could easily pass unnoticed. The trauma which is the inciting cause is often negligible, and is frequently a crushing type of injury. The patients are often classified as malingerers since their injury may have been slight and there is often little objective evidence to justify their complaints.

We have operated upon 6 cases, 5 in the upper extremity and one in the lower. The inciting trauma was a crushing injury or bruise without apparent bony damage in 3 instances, a tearing injury of the hand in one, a phenol burn of the hand in another and a compound fracture of the tibia and fibula in the sixth case. In each case diagnostic injection produced relief of pain and marked increase in the temperature. Operation resulted in relief of the original pain in all cases. In 2 cases where the element of compensation was strong the original pain was relieved but other complaints developed which we believe are in the nature of compensation neurosis.

We feel that traumatic sympathalgia is essentially a traumatic neurosis developing from a pain fixation and associated with vasospastic elements. It is directly attributable to trauma and although probably functional in nature it becomes a fixed

neurosis which can be relieved only by attacking the sympathetic nerves which mediate the painful stimulae. It is possible that blood vessel injury plays a part in the picture. This is a condition frequently overlooked and usually diagnosed as either neurosis, hysteria or malingering.

PAINFUL STUMP AND PHANTOM EXTREMITY

Our early reports in this type of case were very optimistic.[4] Later results have not justified this optimism. Our first case was one of flail arm with a painful phantom arm following brachial plexus avulsion. Ganglionectomy gave marked relief of pain and greatly diminished the phantom arm sensation.

Three cases of painful stump have since been operated on. In only one case has there been any improvement. Since the advent of diagnostic injections we have been able to rule out the sympathetics as a factor in several cases. There is no doubt but that some of these cases may be benefited, but our experience convinces us that most of them are due to central pain, possibly a cerebral pattern. The only type apt to be suitable is the cold stump with excessive perspiration. Even diagnostic injection is not too accurate as at times psychic influences may lead to an erroneous conclusion and a useless operation.

ATYPICAL FACIAL PAIN

Two dorsal operations, both previously reported,[4] have been successful in this type of case. The first case, one of recurrent pain following sensory root section for tic douloureux, gave complete relief of pain for three years. Pain then recurred but a different type of pain, apparently entirely functional. Other men have had completely successful cases of the same type. The second case, a severe pain running from the left eye to the mastoid region in an apparently psychoneurotic individual, has remained a successful result for over three years. Both of these were done before the advent of diagnostic injections.

MISCELLANEOUS CASES

Epilepsy: Bilateral dorsal ganglionectomy was done in a subnormal child of five who had never talked or walked and was subject to severe convulsive seizures. The operation was in the nature of an experiment. There seemed to be some diminution in the severity of the spells and the child became less irritable, but the result was not brilliant. We believe, however, that some cases of epilepsy are due to vasomotor spasm of cerebral blood vessels and expect to do further work along these lines.

Varicose Ulcer of Leg: We have operated in but one such case. Lumbar ganglionectomy caused a rapid healing of the ulcer, but after the patient resumed activity it soon broke down again. Since this experience we have relied on alcohol injections and the results in some cases have been excellent.

Angina Pectoris: Only one patient has been operated on, a very severe case in which the patient made the choice of surgery rather than injection. He expired on the operating table, apparently in an anginal attack, before we had reached the sympathetics. This is our only operative death to date in over 50 dorsal ganglionectomies.

We have treated our angina cases by alcohol injection. The results are excellent, the mortality low, and we feel that the method is preferable to ganglionectomy, unless some other factor is involved.

DIAGNOSTIC INJECTIONS

Diagnostic injection of the sympathetic nerves or some equally accurate diagnostic and prognostic method should precede sympathetic operations.[5] Since the advent of these injections unsuccessful operations have been very few in our hands. As our experience increases we feel that unsuccessful operations will be reduced to practically nil. The day of haphazard sympathetic surgery has passed.

SURGICAL TECHNIQUE

Little need be said about technique. From the standpoint of anatomy and physiology there is little place for any surgical attack limited to the cervical chain. For the upper extremity and head, the approach of choice lies posteriorly by way of the first or second rib and transverse process. The inferior cervical and first and second dorsal ganglia should be removed and all their connections severed, for any of the conditions we have described. The technique has been simplified by using the common tendon of the trapezius and rhomboids as a flap from the midline, and the cosmetic and tensile result is better than the original muscle cutting operations. (Figs. 1–4.)

For the lumbar ganglia we use the retroperitoneal approach of Royle. We have modified the incision somewhat. The incision is made more anteriorly and superior to the crest of the ilium. Instead of separation of the muscle attachments at the crest of the ilium a muscle-cutting incision similar to a kidney incision is made. (Figs. 5–8.) This gives excellent exposure and allows for a firmer closure. We have abandoned the transabdominal approach, because we find this method easier and safer. If necessary both sides can be done at one sitting with greater safety. Since this approach was adopted we have had no deaths and no serious complications in over 50 operations.

ANOMALIES OF SYMPATHETICS

The occurrence of frequent anomalies of the lumbar chain should be emphasized. We find anomalous arrangement of the trunks and ganglia in approximately one out of every 5 cases. There have been as many as six ganglia between the second and fourth lumbar segments. In several cases we have found multiple trunks, as many as five in one case and in this case no ganglia were present. In several instances only one or two ganglia were present; this is most apt to be the case where there are multiple trunks.

A very significant point lies in the fact that we did not discover anomalies in our early cases, and since we are on the lookout for them we find them quite frequently. No doubt failures in some instances are due to incomplete denervation.

Anomalies of the dorsal chain fortunately occur infrequently. When present, however, they present technical difficulties. In a recent case of Raynaud's disease, no well-formed chain and no formed ganglion was found on one side. The trunk was small and placed very deeply, almost on the anterior aspect of the vertebrae. It was removed with difficulty. The other side was normal.

SUMMARY

Raynaud's Disease: Twenty-three operations were performed on 10 patients; 11 for the lower extremity and 12 for the upper. Three of the cases were primarily scleroderma with secondary vasospasm and 2 were primarily Raynaud's disease with secondary scleroderma. The rest of the cases were typical Raynaud's disease. In all of the cases of Raynaud's disease the results were excellent. In the cases where scleroderma was primary the results were very good but not as good as in the other cases.

Thromboangiitis Obliterans: There were 13 operations on 11 patients; 9 for the lower extremity and 4 for the upper. The immediate results were excellent in every case. Only one case has since come to major amputation. There was one death in this series following transabdominal sympathectomy.

Chronic Arthritis: There were 23 operations on 10 patients; 15 for the upper extremity and 8 for the lower. There was one death following the transabdominal operation. This death, together with the one before reported, constitute the entire operative mortality from the lumbar operation. Both of these deaths occurred following transabdominal sympathectomy. Since we have adopted the extraperitoneal approach there have been no deaths. Seven

of the patients have been distinctly improved. There have been 3 failures.

Spastic Paraplegia: There have been 17 operations on 9 patients; 10 for the lower extremity and 7 for the upper. Of the 10 operations for the lower extremity, the results were classified as good in 6, fair in 2, and failures in 2. Of the 7 operations for the upper extremity, 2 were classed as fair and the other 5 as failures.

Three cases of megacolon are reported in which left lumbar ganglionectomy was done. The results in all cases were entirely satisfactory.

There were 5 cases of chronic constipation treated by left lumbar ganglionectomy; all of these have been entirely relieved.

Traumatic Sympathalgia: There have been 6 cases; 3 male and 3 female. The operation has been performed 5 times for the upper extremity and once for the lower extremity. The results were classified as excellent in 4 cases, good in one case, fair in one case, the last 2 being cases in which the element of compensation was strong.

Painful Amputation Stump: There have been 4 patients operated upon, all for the upper extremity. Three of these cases have been failures and one has had a fair result.

Among the group of miscellaneous cases reported were 2 of atypical facial pain, one of epilepsy, one of varicose ulcer and one of angina pectoris. The cases of atypical pain in the face were very successful. The rest of the cases were unsuccessful.

Anomalies of the lumbar sympathetic chain occur in about 20 per cent of cases. There may be multiple trunks or multiple ganglia, and at times fewer ganglia than normal are found. These anomalies may be overlooked and thus lead to incomplete denervation.

Anomalies of the dorsal trunk are infrequent, but when they do occur may lead to technical difficulties in their removal. The trunk may lie quite anteriorly on the bodies of the vertebrae.

These anomalies should always be borne in mind.

CONCLUSIONS

Sympathetic ganglionectomy is very successful in properly selected cases of Raynaud's disease, Buerger's disease, scleroderma, and other conditions where vasospasm is present.

In properly selected cases of chronic atrophic arthritis it affords considerable relief but has not proved the panacea that early reports might indicate.

The lumbar operation is highly successful in Hirschsprung's disease and in chronic disabling constipation. There have been no failures in this type of case.

In cases of spastic paraplegia of the lower extremities due to birth injury the operation is well worth while in carefully selected cases. In spasticity of the upper extremity it is of little or no value.

Traumatic sympathalgia is offered as a name for those painful conditions caused by trauma and mediated by sympathetic nerves. The results in this type of case are excellent.

Operations in cases of painful amputation stumps are rarely successful. The majority of these cases have a central type of pain. The suitable cases may be determined by diagnostic injection.

Some cases of atypical facial pain may be relieved by sympathetic ganglionectomy.

A group of miscellaneous conditions is reported, in most of which the results were not successful.

Diagnostic injection is indicated to select cases suitable for operation. With the benefit of this procedure we feel that unsuccessful cases of sympathetic ganglionectomy should be rare in the future.

The mortality of the extraperitoneal lumbar approach has been nil. Only one dorsal ganglionectomy has resulted fatally, in a severe case of angina pectoris.

Sympathetic ganglionectomy in properly selected cases is a very successful operation attended by an exceedingly low mortality.

[For References see p. 357.]

A CONSIDERATION OF THE TENDONS IN HAND INJURIES*

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THE field of hand surgery is so broad that one must necessarily be restricted to some special problem. I have, accordingly, limited myself to a consideration of the tendons and shall discuss them under two headings, (a) tendon injuries and (b) disposal of the tendons in amputations and disarticulations through the digits.

TENDON INJURIES

Accidental division of one or more tendons is a relatively common condition. In industrial injuries, the extensor tendons are much more commonly involved. This is fortunate as they offer a much better prognosis because (a) they run in sheaths for a very short part of their course; (b) they are not bunched together as in the palm and carpal tunnel and (c) there is no accompanying injury to motor nerves. Packing plant employees seem more liable to these injuries of the dorsum than are any other group.

The majority of wounds of the flexor surfaces of the fingers, hand and wrist, associated with tendon injury, are the result of motor car accidents. These tend to be clean incised wounds but, in spite of this favorable factor, they are much more difficult to treat and offer a less satisfactory outlook, for the reasons previously mentioned.

As stated before, complete division of tendons is a very common complication of incised wounds about the hand. In spite of this universally known fact, they are not infrequently overlooked.

Ordinarily, there should be no difficulty in the diagnosis of a severed tendon. The usual test of function is not safe in all cases. Do not rule out tendon injury on the presence of active movement when that movement can be served by more than one tendon. Do not be in a hurry to test by active motion. It may cause still further retraction of the proximal end.

First of all, look for deformity. Try passive movement of the part distal to the injury and feel if normal resistance be present. In a wound about the hand or wrist, associated with separation of a tendon, passive complete movement of the type normally produced by that tendon will usually make the distal end protrude into the wound.

When ready to begin a tendon repair, first make sure of any ends protruding into the wound. Seize the end gently with forceps or tendon holder and pass a strong thread through the end, then put a hemostat on the thread.

The distal end of a severed tendon is not, as a rule, hard to find. An extensor cut during full extension, or a flexor cut during full flexion will probably not be visible in the wound. By restoring or exaggerating the position at the time of the injury, the distal end can usually be made to protrude.

Retraction of the proximal ends may amount to 2 or 3 inches and prove very troublesome. Some authorities advise rubbing proximodistally. Others recommend the use of an Esmarch bandage, applied tightly from above downward. These methods may succeed but more frequently fail and open exposure is resorted to. Have the patient actively perform the movement opposed to that of the injured tendon, but be sure you have first secured the distal ends. Let us suppose an extensor of the wrist is severed. Have the patient perform

* From the Department of Anatomy, University of Oklahoma. Read before the Oklahoma City Clinical Society, Nov. 4, 1931.

active wrist flexion. The extensors will actively lengthen and I have seen a previously retracted and invisible tendon protrude more than an inch. Active movement is essential. In the example described, passive flexion would throw the extensor into contraction and increase the retraction.

Infiltration anesthesia is usually essential for this, as well as for the method of identification to be presently described.

In multiple tendon injuries, there may be difficulty in identifying the corresponding tendon ends. A knowledge of the normal anatomy of the part is the first essential but is not always sufficient. On superficial examination, all the tendons may look alike but a closer study will show easily recognized variations. Compare the size and shape of the ends, the presence or absence of muscle fibers and their relative proportion, position and direction. Some tendons have sheaths while others have not and some of the sheaths contain one tendon, some two and others several.

In addition to these points of general application many tendons have their own special characteristics. These need not be enumerated here but even a superficial reference to any good textbook of anatomy will furnish the basis for the absolute identification of several tendons.

The most reliable method of identification is probably by functional testing. Since this depends on active muscle contraction, infiltration anesthesia is usually essential, since nerve block at the elbow eliminates motor as well as sensory response, except in the case of the brachioradialis and the extensor carpi radialis longus and, sometimes, the extensor carpi radialis brevis. If the injury is limited to the fingers or hand, nerve block at the wrist will give satisfactory anesthesia without interfering with the movements of the extrinsic muscles. Perform a definite passive movement and note which distal tendon end is most affected. Then ask the patient to perform the same movement actively. The proximal end which is most strongly pulled upon corresponds to the distal end identified by the previous maneuver.

No single method is absolutely reliable but a careful interpretation of the tests previously mentioned should make cross-suture almost unknown.

Large nerves may be mistaken for tendons. The distal end of a divided nerve may often be distinguished by electrical stimulation, but the result must be interpreted with care as it may be an exclusively cutaneous branch. (No cutaneous branch of the median or ulnar nerve is large enough to cause confusion. If the radial nerve splits well down over the dorsum of the hand, its undivided trunk is as large as a tendon but its direction is likely to be somewhat different and it is superficial to the deep fascia.) One must also guard against the effect of over-flow of stimuli. Passive movement of the part distal to the injury will result in a definite pull on the tendons while the nerve, although moving to some extent, will move with the hand as a whole and not with the individual fingers. The best method for the identification of the proximal end of a nerve is active individual movement of the severed muscles. Above the wrist, the ulnar nerve is closely attached to the deep surface of the flexor carpi ulnaris and the superficial branch of the radial nerve is similarly attached to the deep surface of the brachioradialis. Both these nerves will retract, if cut, only with movements of the muscles mentioned. The median nerve, above the wrist, may move slightly with active contraction of the flexor pollicis longus or the tendons of the flexor digitorum sublimis to the index and middle fingers. In any of these cases, the movement of the nerve is relatively slight and tends to lag behind the tendon at the beginning of the muscle contraction. Below the level of the transverse carpal or dorsal carpal ligaments, no nerve will move appreciably, no matter how extensive the injury to the adjacent tendons. If the nerve branches in the exposed area, all difficulty is eliminated and, if one knows the anatomy of the part,

it is sometimes easier to expose a branch than to try any of the other tests.

It is not my intention to describe the technique of tendon suture. I can add nothing of value to that which may be found in any good textbook of surgery. One point in regard to the after-care, however, requires emphasis. Many books say, "Begin movement in the fourth week." If you follow this advice, you will seldom avoid adhesions. In my opinion, movement should never be delayed for more than forty-eight hours and twenty-four hours is usually to be preferred. When only the tendons of the fingers are involved, most patients should be at work by the fourth week. Splints should prevent maximum tension on the suture line but must never completely immobilize it. Thus, after suture of an extensor of a finger, place the hand on a splint which will keep the wrist in extension and prevent full flexion of the fingers but, after the first twenty-four hours, insist on both passive and active movement of the metacarpo-phalangeal and interphalangeal joints.

Sumner Koch[1] has said that one should not attempt primary suture of a tendon more than four hours after the injury. I heartily agree with this, in so far as it applies to tendons in sheaths, but have obtained good results, in tendons without sheaths, as long as twenty hours after the accident.

In the absence of virulent infection, carefully sutured tendons seldom fail to unite. Most unsatisfactory results are due to adhesions.

AMPUTATIONS

The old teaching that, in amputation or disarticulation through a digit, the flexor and extensor tendons should be united over the end of the bone, is still almost universally accepted. In recent years, a few men have advanced the claim that this is unnecessary. I have never seen a scientific attempt to locate and describe the true middle ground between these two extremes, so will briefly state my conclusions based on operative experience and an extensive anatomical study of the tendons and their insertions.

1. In any amputation through the distal phalanx, disarticulation through the distal interphalangeal joint or amputation through the middle phalanx 3/8 inch or more distal to its proximal end, nothing is to be gained by any work on the tendons.

2. Amputation through the proximal 3/8 inch of the middle phalanx will probably separate at least part of the insertion of the flexor digitorum sublimis as it is not attached to the base of the phalanx but to the sides at a more distal level. Anchorage of the flexor tendon, at least, would be indicated but it is, in my opinion, surgically unsound to leave so short a stump distal to the joint.

3. The collateral slips of the expanded common extensor tendon do not pass distally over the dorsum of the proximal interphalangeal joint as freely movable tendons, although all textbooks of anatomy describe them thus. They have a definite attachment to the sides of the head of the proximal phalanx. Because of this, the extensor tendon will not retract when disarticulation is done through the proximal interphalangeal joint and the attachment of the lumbricals and interossei will permit a full range of flexion. I believe, however, that, in a man to whom grip is important, a flexor tendon should be anchored to give stronger flexion and the most convenient means of anchorage is to the common extensor tendon. There are two flexor tendons at this level but to anchor both is to run a great risk of a flexion deformity at the metacarpo-phalangeal joint. In only 4 out of 52 forearms investigated, was there sufficient separation of the different tendons of the flexor digitorum profundus to make individual movement of all fingers possible. The tendon to the index finger was separate in 49 cases. For this reason, the flexor sublimis should be chosen for anchoring,

[1] Koch, S. L. Immediate treatment of hand injuries. *Surg., Gynec. Obst.*, 52: 594–601, 1931.

but this requirement is much less absolute in case of the index finger.

4. In all amputations through the proximal phalanx, the flexor sublimis tendon should be sutured to the common extensor tendon, or considerable loss of flexion, and even some loss of extension, is likely to follow.

5. No tendon anchoring is required in the thumb, distal to the base of the proximal phalanx. In disarticulations through the metacarpo-phalangeal joint, the adductor pollicis, at least, should be anchored.

When you must remove part of a digit because of an acute injury, do not cut any tendon until you have exposed all. This can probably be more clearly illustrated than described.

George L., a sash maker for a lumber company, caught his middle finger in a saw and severed it along an oblique coronal plane beginning on the palmar surface at the distal palmar crease and emerging through the dorsum of the nail. The flexor tendons were cut just proximal to the metacarpo-phalangeal crease while the extensor tendon was intact. The second phalanx was split throughout its whole length so the finger was disarticulated through the proximal interphalangeal joint and the extensor brought around into the palm and sutured to the flexor sublimis. Had the extensor tendon been prematurely severed, a splicing operation would have been required.

SUMMARY

I have given directions for the diagnosis of tendon injuries and for the exposure and identification of the cut ends, from nerves as well as from other tendons. In addition, I have expressed my personal conclusions regarding the disposal of the tendons in operations involving the loss of part of a digit.

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*Continued from p. 353.

TREATMENT OF MINOR INFECTIONS

IN THE DISPENSARY AND OFFICE

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MUCH of the work in the surgical department of an average large dispensary consists in the treatment of minor surgical infections and injuries, chiefly about the hands and feet and frequently in children or young adults. A hospital training in major laparotomies, postoperative care, etc. gives very little experience in the treatment of these minor ailments. It is true that many of them have a great tendency to get well of themselves. However, it is not always appreciated that proper care can lessen the time of the incapacity; or that certain procedures do not affect the duration of the illness, or that others cause unnecessary pain. The purpose of this paper is to discuss methods of handling some of these diseases, chiefly from personal experience.

The topics considered are:

1. Finger infections
   a. Distal phalanx infection
   b. Osteomyelitis of the distal phalanx
   c. Infection in proximal phalangeal regions
2. Infections on the dorsum of the hand
3. Lymphangitis
4. Axillary adenitis
5. Furuncles and carbuncles
6. Infections in children
7. Paronychia
8. Ingrown toe nail
9. The wet dressing.

1. FINGER INFECTIONS

Much has been written about the danger of tendon sheath infections and cellulitis of the hand from neglected finger infections. Nevertheless, true tendon sheath infection is rare as seen in ordinary dispensary and private practice, and most of these infections have a tendency to localize in a few days, into a small pus collection which can be evacuated by a small painless incision.

The treatment of finger infections is primarily an anatomical study: Where did the infection start? Therefore, where must it go? It does not require a medical education to make an incision in the finger or hand; but when and where this should be made frequently demands as much thought as does any acute abdominal condition. There is plenty of opportunity for the exercise of seasoned and mature judgment in determining the proper treatment of these apparently trivial conditions.

a. Distal Phalanx Infections. The distal finger pad is characterized anatomically by many minute connective tissue trabeculae running from the skin directly to the periosteum of the phalanx, dividing the region into numerous closed spaces having a thick overlying skin. Because of the compactness of the finger tip tissue pad, the numerous sensory nerve endings and the multiple compartment-like divisions in the fat, any infection is painful, pus formation is early and under tension, and extension is relatively rapid. This means the danger of early osteomyelitis.[1]

Most of these infections start from a needle prick or similar injury to the tip of the finger, though often a history of the injury is difficult to obtain. Within twelve hours there is a localized throbbing point which shortly becomes unbearable, and the patient walks the floor sleeplessly with an intensely burning digit. Osteomyelitis of the distal phalanx with pus under tension is imminent.

As with all infections, there are all degrees of severity. Sometimes a mild

case will develop as a minute tender spot, which if left alone will discharge a drop of pus in four to six days and then heal with no further ado. In other cases, a similar small localization can be evacuated by a properly timed and judicious incision before it has spread to the periosteum. These milder cases, probably the majority, require very close observation. The picture may change in twelve hours. The guiding signs are the patient's description of his pain: whether it is worse, more intense, spread over a greater area—and the local examination of the tender spot. A localized area of induration may be made out. Auchincloss considers this evidence enough for immediate incision.[1]

For palpation of a small infection in the tip of the finger, one's own fingers are too large to localize accurately. A convenient procedure, which Dr. A. V. Moschcowitz of New York always taught his internes, was to palpate the involved area using the head of a pin, a paper clip, or the tip of a hemostat. This area is watched very closely. If pain and tenderness become intense, and the area is small, the best treatment may be a small incision into it. This can often be done before suppuration develops. A small, dull, edematous bit of fat, which is under tension in its fibrous compartment, is excised and the illness ended. If it is going to localize into a core of pus which will spontaneously evacuate itself, splinting and wet dressings are all that are required until the white core shows; then the overlying skin can be painlessly picked off with the point of a scalpel or scissors. One must be certain that there is no sinus leading to a collar button collection. If pain increases, if there is night pain, or the tender area spreads, it is much better to treat it radically. The wide horseshoe incision in the transverse plane ¼ inch beneath the nail and carried around down to the bone,[2] which is routinely recommended, is rarely necessary in our experience. Each case is an individual problem. We agree with Koch and Auchincloss that an ample incision along one side, evacuating the abscess, in the line of the above semicircle generally suffices. We do not recall a case where the complete horseshoe incision was necessary.

b. Osteomyelitis of the Distal Phalanx. As stated, this almost always follows anterior finger pad infections, although it may occasionally follow a neglected paronychia. We have learned to treat it conservatively. Drainage is all that is required. Frequently a small sliver of bone will sequestrate after three or four weeks, and the process goes on to resolution. Sometimes the entire distal phalanx becomes involved and an *x*-ray will show the entire bone worm-eaten or almost destroyed. It is not necessary to consider amputation. The process rarely extends proximalward, and with patience the bone may completely regenerate. It is hardly necessary to have an *x*-ray taken. The thick purulent discharge coming from a sinus-like opening is diagnostic, and the therapeutic indication is not changed after *x*-ray examination.

If the discharge is free and there is no retention, the treatment consists of dry or moist dressings and splinting. If there is retention or pain, further incision for drainage, preferably along the semicircular line beneath the nail, is indicated. If the pus points to one definite area it may be better to incise here, since one sinus opening is generally adequate to avoid retention if granulations are kept from plugging it up. We have been in the habit of not incising too freely, using perhaps one-half or one-quarter of the circular incision.

For a complete and original description of the spread of finger tip infections proximalward, the reader is referred to the above article by Auchincloss.[1]

c. Infections in Proximal Phalangeal Regions. Here, careful watch must be kept for possible tendon sheath involvement. Where the infection started and hence where it *must* go are doubly important. The dangerous anatomical site is

near or just proximal to the flexion crease of the finger tip, where the flexor tendon inserts. Infections starting here may travel up into the hand, destroy the endothelial lining of the sheath, and cause a permanently crippled hand within thirty-six hours. Excruciating pain, tenseness and stiffness of the finger, originating at this site perhaps in a slight skin abrasion no deeper than a scratch, cause one to deliberate carefully on the advisability of immediate wide incision of the tendon sheath. By far the greater number of finger infections, however, are of lesser severity and localize in the anterior closed space, the loose subcutaneous tissue lying between the flexor tendon and the skin on the flexor surface. Again there are all gradations of severity. A rapid, virulent, poorly resisted cellulitis may extend quickly to the contiguous tendon sheath, especially if movement is allowed. This is not the usual course, however. With splinting and frequently changed moist dressings, most of them will either spontaneously evacuate themselves or pus can be reached by a small incision in the lateral border of the anterior closed space. Sometimes they spread to the so-called collar button abscess in the finger web; or a neglected case may form a deep palmar abscess.

The criterion for incision, unless there is rapid extension, is that easily obtainable pus will be found. If it can be made out that the tendon sheath is not involved, it is better to wait two or three days before incision. Healing is much quicker and surer. Tendon sheath involvement causes pain on very gentle extension of the finger, and the tenderness over the sheath of the flexor surface (tested for with a small blunt instrument) involves the whole finger rather than the area of the abscess, and increases. As an abscess forms, this area becomes more tender and the more distant regions less so.

With care, gentle finger palpation for fluctuation can be quite accurate. The left forefinger is placed on one side of the involved digit, to receive the impact transmitted through the flexor surface from gentle tapping with the right forefinger on the opposite side. This maneuver is often carelessly applied. The gentlest touch suffices, and no pain should be produced.

As noted, if one waits until localization has taken place, a small incision, preferably on the lateral border suffices, or if the center is on the midflexor surface, directly overlying the lake of pus. It is not our usual practice to insert a drain. Often as not it acts as a plug. Counter drainage through the finger is not often indicated. Tht next day the edges of the incision may be spread by a small artery forceps if retention is suspected. Frequent moist dressings for one to three days, during which careful watch is maintained for possible extension toward the hand, usually completes the trying period.

2. INFECTIONS OF DORSUM OF HAND

Infections on the dorsum of the hand are entirely different. They usually start from hair follicle infections. The tissues swell inordinately because of the looseness of the skin, but there is very little tendency to extension and spontaneous localization is the rule. The core may be touched with a drop of pure carbolic acid.

3. LYMPHANGITIS

Lymphangitis, with red streaks up the arm and tender elbow and axillary glands, is presumptive evidence that no pus has collected or generally will not collect. This usually follows a relatively insignificant skin infection, such as an unprotected scratch or follicle infection. Again, the cure of lymphangitis is carefully applied moist dressings to the original scratch. Drainage from the fourth and fifth fingers is to the anticubital-epitrochlear glands at the elbow; and from the thumb and second finger directly to the axillary glands. The third finger drains to either group, occasionally directly to the supraclavicular glands above the clavicle and

hence injury here may produce rapid systemic symptoms.

The explanation of many cases of swollen inguinal glands, chiefly in young boys, lies in slight infections about the toes, feet, shins, etc. The cure is bathing and cleanliness of the feet and legs.

Treatment of the local lesion is much more important than icebags, heat, poultices of the axillary or inguinal glands.

4. AXILLARY ADENITIS

This is often a bugbear. If due to lymphangitis from the fingers or hand (usually the radial side of the hand) the treatment is care of the original infection, observation, and heat to the axilla until fluctuation manifests itself, then incision. Little will be accomplished by incising before suppuration has liquefied the involved glands. Occasionally the streptococcus invasion is extremely virulent, and slight jaundice may supervene before suppuration develops.

The troublesome axillary infections are those due to furunculosis about the roots of the axillary hair follicles. The infection works down to the lymph glands draining the particular follicle, then spreads to a neighboring gland. Another furuncle develops from the first by reinoculation of the infectious material into a new hair follicle and the process is repeated. As the patient walks about, the arm waving in discomfort and pain, new crops start before others heal. The axilla becomes a mass of pustules and swollen glands in various stages of catarrhal exudation, pus formation, and inflammatory fibrous sclerosis.

The cure rests upon the realization that the process spreads locally from one part of the axilla to the other and is not, until late, a general invasion of the entire axilla; and that rest and skin cleanliness are essential.

First, cleanse and shave the axilla, including the hairs about small furuncles and skin abscesses. Next open all pustules and superficial abscesses and apply wet dressings. Third, enjoin rest in bed with the arm at right angles and apply external heat. The next day the skin is carefully cleansed with alcohol. Any new pustules should be opened. Incisions should only be made if liquid pus is actually present. Incisions through this tender, inflamed, movable skin are painful for several days if no pus is found; but when made directly over an abscess they bring immediate relief. The spread of the skin furunculosis can thus be controlled in three to five days. It is often time saved to spend fifteen to twenty minutes twice a day dressing these patients for two or three days until all this superficial infection is controlled. As soon as there is no more skin infection, the underlying glands which drain them will subside (just as inguinal glands do after the feet have been washed). Incision into the deep glands should be made with caution therefore, and only if they are frankly fluctuating and not retrogressing. As soon as the skin has stopped cropping out new boils, a dry hygroscopic powder (bismuth formic iodide) dressing is used.

A few days of such care if conscientiously applied will cut short a painful illness which has incapacitated an active individual for three or four weeks.

5. FURUNCLES

We have been satisfied to carefully cleanse the adjacent skin, apply a small dry dressing, splint the part, and wait two to four days until the greenish white cap develops. We then lift this off painlessly, evacuate the drop of pus which forms for two or three days, and that is all. A wet dressing is not used because the staphylococcus, with continuous bathing of the macerated skin about the original focus, very easily penetrates and forms another furuncle. Plunging a needle or toothpick dipped in phenol, etc. into the center of the involved hair follicle is a time-honored and well-vouched-for treatment.

Absolute rest, heat, dryness, and cleanliness of the skin are the essentials in the preliminary stages.

We have not known of any systemic treatment which will prevent recurrent crops of boils or shorten their course. We have not used any general measures except limitation of carbohydrate intake, and have treated persistent and recurrent skin infections according to the foregoing routine. Dolman[4] has recently reported very favorable results in these cases following injections of staphylococcus toxoid; i.e. immunization against localized staphylococcus infection quite analogous to that against diphtheria by diphtheria toxoid injections. Staphylococcus produces a true exotoxin which Dolman believes is responsible for many of the observed pathological changes. This toxin, obtained from several virulent lesions, was treated with 0.3 per cent formaldehyde, producing the staphylococcus toxoid, thereby detoxifying it but preserving the antigenic properties.

Injections of toxoid are given every five to seven days (0.05 c.c. to 0.2 c.c.). Clinical improvement parallels the demonstrated increase in the circulating blood of staphylococcus antitoxin. Whether the immunity conferred is of as long duration as that in diphtheria is not yet known, but marked immediate responses with several months subsequent freedom have been obtained in recurrent boils, pustular acne, recurrent pustular eczematization of skin, staphylococcus sinusitis, etc.

Carbuncles are multiple-mouthed furuncles which form where the skin is thick and the subcutaneous tissues are fibrous and compact, as in the back of the neck or the upper lip. The problem is drainage. Many will resolve themselves if left alone until a core forms. Others require crucial or radical excision, sometimes complete excision and packing with zinc chloride. Carp[5] has recommended injection of a few syringefuls of blood from the patient's elbow vein about the indurated area of the carbuncle.

The danger of the spread of infection of the upper lip to the intracranial sinuses is well known. Rest is the essential here. Talking or moving the lips should be interdicted. If necessary, a large bandage covering most of the face to splint and immobilize the lips should be applied.

We are not convinced that the normal defense powers of the body need any other aids such as vaccines, poultices, bacteriophage, tin, antiseptics, *x*-ray therapy, etc. for the eradication of the average furuncle, boil, or even small carbuncle. At least in our experience the foregoing simple measures have proved sufficient. Carp[6] has shown how difficult it is to draw conclusions from one form of therapy in these conditions when others have been used, and how easy to fall into "post hoc propter hoc" reasoning.

Mild *x*-ray therapy is credited with aborting 50 per cent of all boils and carbuncles if applied within the first two or three days, and affording considerable relief, analgesia, and shortening the disease in many of the remainder.[7] How many boils abort spontaneously is not known. We have thought *x*-rays helped some boils, but as often were not sure.

Bacteriophage is increasing in use in several places. We have had no personal experience with it, though certain colleagues are enthusiastic. A recent report[6] concludes as follows: "clinically gratifying results in spite of lack of knowledge of the principles involved have been the rule; . . . opportunity for carefully controlled clinical experiments . . . is urgently needed."

6. INFECTIONS IN CHILDREN

Children pick up numerous skin infections. The difference between any infection in childhood and the same process in the adult is that the delicate tissues are invaded and overwhelmed more rapidly, but then there is more rapid and better localization and cure.

Most of these abscesses if left alone will localize of their own accord. They can then be evacuated by simple picking-off of the dead epithelium over the underlying lake of pus, or, more rarely, a short quick incision under ethyl chloride spray. We

rarely use drains in children, even though the abscess is rather large. The next day the wound may be spread apart with an artery clamp if retention is suspected. If one has waited until the abscess is well developed before incising, there will be very little tendency toward extension.

A favorite site of suppuration in the child is underneath the finger nail, from a blister in the tip of the finger. If the nail is loose, it can be partially excised without pain; this allows immediate drainage and the infection will be dry in two to three days.

Neck abscesses are frequent in children. Pediatrists know that healing is quicker when one waits three to six weeks for the gland to break down completely than when an incision is made immediately. If the abscess is behind the sternomastoid muscle, deep drainage behind the muscle is necessary. If one waits until adequate resolution has taken place, however, this is not often necessary. These abscesses frequently burrow or pocket beneath the densely investing cervical fascia, which then contracts down about the drainage tube. Though drainage is profuse, there is still tenderness, tenseness, fever and malaise, but fluctuation is not so evident. It is necessary to widen the incision and spread the wound apart with scissors. Local anesthesia should be used in all these cases, for there is a certain danger of edema of the glottis when general anesthesia is induced in the presence of neck suppuration.

An important part in handling children with painful sores, blisters, etc. is care that the procedure whenever possible should be painless. If pain cannot be avoided, the child must be prepared for this so it will not come as a painful shock. Once hurt, especially after a promise not to hurt, a child's confidence is lost and further dressings are an ordeal. Many adult inhibitions against doctors date from the psychic trauma of a painful, to them a terror-striking ordeal of a childhood medical encounter, frequently of a minor surgical nature.

It is not necessary to do much handling of the infected area; practically all the information (except the gentlest palpation to determine fluctuation) can be obtained visually. If abscesses are allowed to localize, few drains used, and moist dressings carefully applied, it is surprising how little pain will accompany the entire treatment.

7. PARONYCHIA

Manicures are responsible for a large percentage of the paronychia seen clinically. It is not necessarily the infection introduced at the time of the cutting of the cuticle and edge of the nail which causes infection, but the break in skin surface produced and the resulting chance for infection.

The typical paronychia starts with a red hot tender area alongside one edge of the nail bed two to four days after the injury. It is apt to be rather painful, and invite incision, and there is a certain danger of its spreading around the base of the nail, the typical "run around." It is much better to observe this for a few days longer; for in the vast majority of cases, a small abscess will localize close to the edge of the nail, take on a greenish "cap," and the dead overlying skin can now be removed with a forceps and the pus evacuated. One must be careful that there is not a second pus collection directly underneath the blister, but still overlying the nail.[1] After another two or three days it is healed. If the infection has spread underneath the nail at its base, the so-called subungual abscess, very frequently the nail overlying this area can be excised with a small sharp scissors. Since this portion of the nail is loose from its substructure, the procedure is painless. The nail is clipped back to the cuticle margin (the posterior margin of the nail is generally loose and easily freed) and anteriorly over the nail bed as far as it is detached, but no farther. This provides for drainage. After one to three days, if the infection has spread, a further portion of the roofing

of this subungual abscess is exposed. Very shortly the nail bed will become dry and stay dry; the progress of the infection has been stopped.

The finger is left with a protecting anterior portion of nail, so that it is not so sensitive for the eight to twelve weeks required to grow a new nail. It must be seen at intervals, however, and the loose portion of the nail trimmed, so that the young growing edge of nail proceeding from the matrix is not cramped.

The foregoing treatment requires no anesthetic. Very rarely is the nail removed, although occasionally this is indicated in neglected cases.*

8. INGROWN TOE NAIL

If the case is recent, frequently it can be relieved by triangular excision of a small portion of the lateral edge of the nail. It is best to pack a small rolled pledget of cotton underneath this edge, being careful to get underneath the proximal angle of the triangle. This must be changed every two or three days until the nail has grown out. The patient can generally be taught to do this himself with a small pair of tweezers such as are used for blackhead removal (purchased in any drugstore). The foot is bathed in boric acid solution twice a day if there is infection. Care must be taken that the toes are not cramped by tight or narrow shoes. If the toe is tender, it is better to wear a slipper or old shoe with a portion of the toe cut out. Many ingrown toe nails can be cured by care and patience with no more radical procedure than the foregoing. It may be difficult to get the cotton pledget underneath the proximal angle of the nail at first, but after a few days this is easier.

If the condition has lasted longer, this treatment has failed, suppuration and pain continue, or cooperation is poor, a radical excision of the lateral portion of the toe nail including the angle of the matrix should be done. This is always a dispensary or office procedure under local infiltration anesthesia. The patient is told to take a warm boric foot bath twice a day for a few days before the operation if there is considerable infection. Pitkin[9] advises regional block of the dorsal cutaneous nerves at the base of the toe, 2–3 c.c. of 1 per cent novocaine solution on each side of the phalanx being used. We have also used local infiltration, beginning in the loose tissues behind and lateral to the nail bed then along the lateral border of the nail across the tip of the toe to the midline. Either is satisfactory.

The nail is incised with a stout sharp scissors longitudinally on a line about one-quarter the distance from the lateral border toward the mid-line of the nail. It is not necessary to take away a wide piece of nail; but, in order to prevent recurrence, it is necessary entirely to excise and destroy the matrix of the involved angle. The linear incision is carried proximalward past the base of the nail, and 3/8 inch into the soft tissue of the dorsum of the toe, one blade of the scissors being kept firmly against the bone and deep to the nail as it advances. A small tourniquet (small catheter or rubber tubing) is now applied tightly around the base of the toe to insure a bloodless field when the nail bed matrix is excised. This is important. The soft part incision is now curved outward and carried distalward. The wedge of tissue so outlined is excised deeply down to the bone. The lateral sliver of nail comes away in the center of this. The matrix angle is thoroughly cleared and any remaining loose tissues or matrix fragments are excised with a sharp knife. The cavity is then carefully curetted and packed tightly; the tourniquet is removed; and a firm bandage applied.

After care is simple: change of dressing daily or every other day and daily bathing if the infection still persists.

* When infections about the nail bed heal with a split nail, the reason is that prolonged suppuration or trauma to the delicate nail bed has permanently injured it. Both should be guarded against; the infection terminated speedily, and gentleness in handling the matrix structures scrupulously practiced.

9. WET DRESSING

Perhaps the most valuable article in the therapeutic armamentarium of the out patient department is the wet dressing. If one is inclined to experiment, whatever dressing is applied to the average wound: salves, pastes, powders, drugs, etc., one almost always comes back to the frequently changed mild moist compress; the wounds look cleaner, granulations are healthier, and healing is always more active. Accordingly, it is worth while inquiring briefly into the physiology of wound healing and the reasons for the efficacy of a wet dressing.

Cutting[10] states that "greater progress has been made in the treatment of infected wounds during the last fifteen years than in all the centuries preceding." This progress is chiefly the realization of the principles of "biological antisepsis," i.e. the impossibility of sterilizing a wound by the use of chemical antiseptics, hence dependence entirely upon aiding the physiological or biological agencies which make for natural recovery.

The normal human plasma serum or lymph possesses very marked bactericidal powers. Bacteria grow by tryptic digestion of their surrounding media. Blood serum contains an antitryptic substance which inhibits this. The only organisms which will grow in such fluids in reasonable numbers are streptococci and staphylococci and some forms of diphtheroid organisms will grow to some extent. These organisms have the power of overcoming the normal antitryptic powers of serum and obtain nutriment by digestion of the proteins of the body fluids.

The second important body defense against infection is the leucocyte. In the current of the bloodstream, or suspended in an effusion, they are merely carried along in scant numbers. If a flat surface such as a wound, fibrin or gauze, is the media, they will anchor in large numbers and "haul themselves about from place to place."[11] In contact with cellular debris, sloughs, or bacteria, they disintegrate, liberating a tryptic ferment which digests the foreign substance.*

After a certain length of time or in a recent badly infected wound, the concentration of dead cells, tissues, and leucocytes becomes too great; the wound "becomes tryptic," i.e. the liberation of trypsin provides a good culture media for bacterial growth, and the increase in fluids slows up the leucocytes tremendously. "A wound which contains any appreciable amount of effusion is a wound which cannot be sterilized by leukocytic agency."[11]

The two processes are thus somewhat antagonistic; antitryptic powers of the lymph and plasma, and tryptic digestion by disintegrating leucocytes. "On the one hand we want the antitryptic power maintained to prevent the growth of organisms, and on the other it is necessary to rid the wound of slough by tryptic digestion."[12]

* Fleming[12] demonstrated their antibacterial powers by a very simple experiment. He gently syringed the wound with salt solution, washing off the leucocytes, and took cultures before, immediately after, and at two hourly intervals up to twenty-four hours later. "Before the dressing a number of colonies develop between the pus islands. Immediately after the dressing there are many more colonies, as most of the pus cells have been washed away by the saline; but many microbes remain and can grow unhindered. A specimen taken an hour and a half after dressing still shows a few colonies; but the four hour and eight hour specimens remain sterile, as here the freshly emigrated leucocytes are capable of dealing with the infection. The specimen taken twenty-four hours after dressing shows practically the same condition as the first specimen. This change from the eight hour to the twenty-four hour specimen is probably due partly to the degeneration of some of the cells and partly to the collection of fluid under the protective. The leucocyte does not swim freely in fluid, but apparently only shows active movement when it has some point of attachment, so that in any fluid collection it only exercises its functions fully on the walls of the cavity. A consideration of this is of the greatest value in wound treatment, as it explains why it is necessary to bring the surfaces together in suturing these wounds to obtain healing without suppuration, and why it is that in cavities which normally contain fluid, or into which fluid is rapidly poured as a result of an infection of pyogenic cocci, such an infection tends to have very grave results. The body fluids normally have no bactericidal action on these cocci and the leucocytes do not have a fair chance of combating the invasion in the presence of much fluid."

The ideal dressing is one which for a long time promotes the flow of lymph and brings fresh leucocytes to the wound; then by becoming dry and absorbent, allows this latter phase, tryptic digestion, full play for a time. This is the rationale of frequent changes in dressings. The drying must not be too prolonged, for after a dressing has been in contact with a wound for several hours a thick film of wound secretions, leucocytes and debris collects, through which osmosis is hindered and in which it can be shown that the movements of the leucocytes are much diminished.

In practice, changing every twenty-four hours usually suffices. Fleming's experiments seem to bear this out.* Precaution should be taken that the dressing should not become hermetically sealed; the oil silk should be cut smaller than the underlying gauze. Also, smooth and firm contact of gauze with the wound should be maintained; a better scaffolding for the leucocytes is thus made. The dressing should often be "built up" and care taken that it does not slip. Rest, as splinting, large protective dressings to the face, sandbags to neck and head, a long forearm splint for hand infections, are important adjuncts.

In this rationale of the physiology of wound healing, this "biological antisepsis," chemical antiseptics have no place. Dakin's solution, mercurochrome, aniline dyes, etc. have three drawbacks: (1) they must act in a complex serous, purulent, or bloody medium where their potency is invariably much diminished; (2) the body cells fighting these bacteria are just as vulnerable to poisons, if not more so, than are the invading organisms; (3) in any infected wound, the bacteria have already spread beyond the wound edges into the fixed tissues far from the power of any dye or antiseptic to penetrate. For these reasons many investigators feel that the value of chemical antiseptics in wound healing is nil.[10]

The time-honored solution is boric acid, a weak antiseptic scarcely soluble in water (4–5 per cent). Some, as Blair,[13] believe the kind of solution does not matter so long as it is changed frequently. Almroth Wright and Fleming recommend hypertonic salts, preferably the less irritating magnesium sulphate in a 5–10 per cent strength. Two heaping tablespoonfuls to one quart of water make a 6 per cent solution. Hypertonic solutions exert osmotic tension and more actively aid the withdrawal of lymph from the environs of the wound. Leucocytes coming in contact with such a solution are immediately broken up, liberating trypsin. The salt solution soon becomes diminished in strength so that all inhibitory action on tryptic digestion is lost, and the liberated trypsin can act without hindrance on the sloughs. Meanwhile, as soon as the strength of the salt solution approaches normal, fresh leucocytes emigrate into the cavity of the wound. These are destroyed with the next application of hypertonic salt; and so that process goes on until the wound is clear of sloughs.

* If the infection is bad, or there is virulent lymphangitis, changing every eight hours is advisable. Better still is the "immersion treatment": immerse the part in a warm bath for fifteen minutes, and apply a dry dressing for three to four hours. With such frequent changing, one must be careful lest added infection be introduced from the outside by handling.

COMMENT

"There is no greater field for good surgery than is presented by minor surgery." "For the solution of many of the problems of minor surgery considerable knowledge, judgment, and skill will be needed. There cannot be too much instruction in minor surgery." "C'est par l'étude de la petite chirurgie que le chirurgien commence son apprentissage."

These three quotations, from the front pages of Christopher's "Minor Surgery," indicate the importance of a phase of surgical practice which is often thought lightly of, or delegated to others. The foundation of life-long methods of procedure, invaluable in major surgery, can be laid in the routine care of these minor

conditions. Habits of diagnosis, weeding non-essential procedures from those that are essential, critical observation of end-results, testing of various methods, can be developed. The patient is awake and sensitive. Gentleness in handling, respect for living tissues, so essential in any surgical operation, can be learned in out-patient care of minor infections and injuries as well as in the operating amphitheater.

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DUODENITIS*

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OCCASIONAL writers have long recognized duodenitis as a pathological entity but until recently it has not been generally considered except as a complication of ulcer and as a cause of catarrhal jaundice.

The use of the duodenal tube, roentgenological studies and the increasing number of observations of surgeons and pathologists indicate that this condition occurs more commonly than is perhaps realized.

It is with the hope of stimulating a wider interest and study of the problem that the following résumé is presented.

One of the first monographs was by Broussais, in 1825, who enlarged on the subject in his "General Course of Therapeutics and Pathology" in 1834. Other early writers were Barby, 1836, Baudin, 1837, and Kuhff, 1874. Mention should be made of the writings of Hunter, Dupuytren, Moxon, Perry and Shaw, Lesage, Gaultier, W. J. Mayo, Judd and Nagel, MacCarty, Carman, Kirklin, Nickel, Blankinship and Oatway, Hufford and Johnson.

MacCarty in 1924 presented a study of excised duodenal ulcers and demonstrated the uniform association of duodenitis with that lesion.

Judd and Nagel in 1927 described the type of duodenitis resembling ulcer and Kirklin in 1929 discussed the roentgenological findings.

The bacteriological studies of Nickel, 1929–1930, the study of symptomatology by Blankinship and Oatway, 1930–1931, and the clinical study of Rivers, 1931, should be noted.

Gaultier, in his "Les maladies du duodenum," subdivides duodenitis into catarrhal, suppurative, proliferative or interstitial and ulcerous processes.

The symptomatology, clinical and pathological findings justify the following classification: chronic duodenitis; simple acute duodenitis without ulcer symptoms; the ulcer type of duodenitis which presents symptoms suggestive of ulceration and phlegmonous or gangrenous duodenitis. Most of the recent work deals with the ulcer type.

The following case reports illustrate variations in the problem:

CASE I. *Duodenitis with ulcer symptoms and superficial erosions.*

A male, aged thirty-eight, with negative past history except for diseases of childhood, for two years had complained of pain from two to three hours after meals, occasionally awakening him at night, relieved by food and alkalies. There had been a moderate loss of weight but no vomiting, hematemesis or melena. On examination, epigastric tenderness was found and an excess of free hydrochloric acid. The motor function of the stomach was good. The tape test showed a blood-stained area over the portion stained with bile. The *x*-ray diagnosis was duodenal ulcer.

As symptoms persisted in spite of medical treatment, an operation was performed. The duodenum presented a doughy consistency without palpable ulcer. The pylorus was incised and the mucosa was found to be congested and thickened for a distance of one inch from the pylorus. It bled easily upon manipulation and two minute erosions were observed but no actual ulcer. Recovery followed a Judd and Nagel pyloroplasty.

CASE II. *Duodenitis with ulcer symptoms and hemorrhage with an absence of free hydrochloric acid.*

A male, aged forty-four, who had been exposed to mustard and phosgene gas in 1918, in that year had a hemorrhage believed to

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be pulmonary in origin but without evidence of tuberculosis. Appendectomy was performed in 1920. In 1930 he developed a sense of hunger two to three hours after meals without real pain. In May, 1930, he had headache with vomiting of bile followed by fresh blood. He was treated for ulcer for two months although *x*-ray examinations did not reveal a lesion.

For four months previous to examination he had had attacks of fullness or dull pain, usually after a meal of meat or heavy food, which was relieved by alkalies. During attacks there was heartburn, weakness and soreness in the epigastrium and at all times a sense of discomfort upon deep pressure above and to the right of the navel. After a heavy meal he complained of headache and vomited repeatedly; the last time the vomitus contained blood. Physical examination was negative except for moderate tenderness above and to the right of the umbilicus and evidence of chronic myocarditis. The Wassermann and Kahn tests were negative. A test meal showed an absence of free hydrochloric acid and total acidity of 8 to 12.

X-ray examination of the chest was negative. There was no evidence of gastric or duodenal ulcer. Esophagoscopic examination was negative. Tape tests showed traces of blood over the bile-stained portion. Duodenal lavage showed mucus, epithelium, leucocytes and occasional erythrocytes. No operation was performed but because of persistent tenderness over the duodenum, traces of blood obtained with tape tests, the findings upon duodenal lavage and negative *x*-ray examinations, a diagnosis of duodenitis of the ulcer type was made. The patient remains comfortable upon a bland diet and the use of atropine and bromides.

Case III. *Duodenitis without ulceration terminating with fatal hemorrhage.*

A male, aged fifty-two, for ten years had had symptoms suggestive of duodenal ulcer, which was confirmed by *x*-ray examination two years ago. Following a period of freedom from symptoms he had a sudden profuse hemorrhage, both melena and hematemesis, with marked prostration. After admission to the hospital hemorrhage recurred and, despite transfusions, the patient died. At autopsy the first portion of the duodenum for a distance of 1½ inches was of doughy consistency, edematous and inflamed. At several points there were punctate ecchymotic spots, apparently the source of the hemorrhage. No ulcerations were demonstrable. There was a sinus extending from the first portion of the duodenum into the pancreas that held a small amount of barium, apparently retained from the *x*-ray examination two years previously. There was no evidence that the hemorrhage came from this sinus.

Case IV. *Gangrenous duodenitis.*

A male, aged fifty-six, was intoxicated when admitted to the hospital. It was stated that following several days of intoxication he drank plumber's fluid which contained either hydrochloric or sulphuric acid. Examination suggested a perforated ulcer. No perforation was found at operation but the duodenum, from the pylorus, as far as it could be inspected, was black in color. No procedure was attempted and death occurred a few hours later. At autopsy the mucosa of the stomach was almost entirely denuded but the muscularis appeared uninjured. The duodenum, from the pylorus to the duodenojejunal junction, was gangrenous but was not perforated.

ETIOLOGY OF DUODENITIS

The fact that the duodenum is less mobile than the remainder of the intestinal tract and that it lies in a network of lymphatics which drain the region of the appendix and gall bladder, the most frequently infected areas of the abdomen, may explain the frequency of involvement, which, it is claimed by some observers, is only exceeded by that of the appendix and stomach (Roeder). Askanazy suggests that traumatism affects the duodenum more readily than the remainder of the intestines because of its fixed position and opens the way to infection by way of the blood stream and lymphatics or by ascending infection of the intestines.

Duodenitis is more frequent in men than in women. In 223 collected cases, 164, or 73.5 per cent, were men and 59, or 26.5 per cent, were women (Nagel, Rivers, Hufford, Blankinship and Oatway).

The average age, according to Johnson, was thirty-three but Hufford and Blankinship and Oatway place it at forty years. The latter found that 85 per cent were engaged in occupations requiring mental

rather than physical effort, although in other observations the disease was equally prevalent among those in active and sedentary occupations.

The experimental production of duodenitis described by William Hunter in 1890 has been extensively quoted. He injected toluylenediamine into the circulation of dogs, producing destruction of blood corpuscles, jaundice and duodenitis without involvement of the remainder of the intestinal tract. There was swelling, congestion and inflammation having its greatest intensity about the opening of the bile duct and gradually fading below.

In a case with ulceration, the ulcers, corresponded to groups of follicles without loss of substance. The most striking features were the relation of the inflammation to the opening of the bile duct and the recognition of toluylenediamine in the bile, from which Hunter concluded that the excretion of toxic matter in the bile may cause duodenitis. He suggests a similar process in duodenitis associated with burns and other septic conditions.

Other experiments have shown that, after ligation of the common duct and injection of toluylenediamine, duodenitis followed, but this does not detract from the value of Hunter's experiment.

Duodenitis regularly accompanies and probably precedes acute and chronic ulcer and may complicate infectious fevers, gastritis and gastroenteritis.

Congestion of the duodenum and enlargement of Brunner's glands were observed by Perry and Shaw in acute specific diseases as follows: chorea, 4; typhoid, 2; lobar pneumonia, one; septic processes, 5 (i.e., gangrene, one; sloughing wounds, 3; pyemia, one); tuberculosis, one; chorea and endocarditis, one; Addison's disease, one; bronchitis, one; granular kidney, 2. Hemorrhagic erosions were noted in 10 cases.

Curling, writing on ulcer complicating burns, describes congestion of the duodenum as regularly present and cites the following case of inflammation of the duodenum without ulceration.

A girl, aged thirteen, was admitted to the London Hospital severely burned on the face, abdomen, arms and knees. She died three days later. At autopsy the stomach was normal, the mucosa of the first portion of the duodenum presented a uniform bright red appearance which terminated abruptly at the pylorus but below shaded off gradually beyond the opening of the bile duct. Brunner's glands were distinct and large, with numerous vessels interspersed among them. There were enlarged lymphatic glands in the vicinity of the duodenum. The remainder of the intestinal canal was normal.

In uremic ulceration of the duodenum, general congestion and inflammation of the mucosa, particularly of the valvulae conniventes, have been described according to Dickinson, Barie and Delaunoy.

Tuberculosis and anomalies causing duodenal stasis were predisposing factors in many cases studied by Johnson who also notes that intestinal parasites are frequent offenders. In more than 20 cases of hookworm infection he found duodenitis or ulcer.

According to Wellbrock "inflammation of the duodenum with and without erosions may be caused by a single factor or a combination of factors as trauma, high temperature (heat), strong acids or alkalies, vascular disease, emboli, functional disturbances and allergic reactions." Rivers suggests that many cases of bleeding occurring in cases of appendicitis and cholecystitis are due to associated duodenitis or gastritis.

Alcohol, tobacco and the excessive use of cathartics are believed to be contributing factors.

Chronic infection of the duodenum is not unusual, particularly when it is deprived of the protective action of normal gastric secretion and the digestive activity of the duodenal fluid is impaired.

Under normal conditions the duodenal fluid destroys B. coli, Streptococcus viridans, hemolytic streptococci, pneumococci, and apparently staphylococci. Under pathological conditions this property may be impaired but is not necessarily lost accord-

ing to Loewenberg. McNeal and Chace and Ricin, Sears and Downing found that the normal duodenal fluid is practically free from living bacteria but in various gastrointestinal disturbances the former investigators obtained cultivatable bacteria consisting of Gram negative gas forming bacilli, cocci, yeast, B. typhosus and occasionally B. coli.

Ricin, Sears and Downing found the duodenal contents of achlorhydric patients rich in bacteria, many of which possessed blood destroying properties, notably the Streptococcus viridans and a hemolytic colon bacillus.

In 4 cases of pernicious anemia with achylia gastrica, observed by Rave, the duodenum was infected with B. coli in all and with staphylococci in 2.

In the ulcer type of duodenitis various bacteria have been demonstrated including streptococci, staphylococci, pneumococci, colon bacilli and the bacilli of typhoid, diphtheria and tuberculosis.

Nickel obtained cultures from 21 patients in whom duodenitis without ulceration was demonstrated at operation. "Eighteen of these had one or more foci of infection which contained a streptococcus with selective affinity for the stomach or duodenum."

A large percentage of rabbits injected with cultures from the teeth, tonsils, and the prostate gland developed hemorrhagic lesions of the duodenum or stomach. When cultures obtained from the surgically resected tissue of the stomach or duodenum consisted predominantly of green-producing streptococci, intravenous injection into rabbits usually caused acute hemorrhagic lesions of the stomach or duodenum. If the cultures injected consisted mainly of bacilli or staphylococci or other nonpathogenic organisms, lesions of the duodenum or stomach or lesions elsewhere in the body were relatively infrequent.

Hufford maintains that the organism is essentially the same in duodenitis and peptic ulcer, the difference depending upon the reaction of the duodenum to the organism.

CHRONIC DUODENITIS

If we accept as evidence the presence of stringy mucus, large quantities of epithelium, leucocytes, and erythrocytes in the aspirated duodenal contents, after thorough cleansing of the stomach and without the presence of bile, chronic duodenitis is of frequent occurrence.

Apparently it may be primary, may follow acute duodenitis or may be secondary to inflammatory conditions in adjacent structures, and is subject to exacerbations with acute symptoms.

The duodenum may be atonic and dilated. The serosa and mucosa may be congested, the latter covered with granulations, and connective tissue formation may be observed. External evidence consists of thickening and contraction of the hepatoduodenal ligament, and adventitious bands varying from cobweb adhesions to thick membranes which may unite the duodenum to the liver, gall bladder or stomach, or may bind together the first and second portions or may be found retroperitoneally at the inferior angle uniting the second and third portions; the periduodenitis of Duval; the adhesive duodenitis of Bassler.

Similar bands may be caused by ulceration, cholecystitis and colitis. Obstruction may be caused by bands and membranes or by mesenteric compression of the third portion. Jaundice may occur as a complication.

The symptoms are vague. It is probably this form that Lipschutz has in mind when he speaks of abdominal distention, belching, nausea, and vertigo after eating. He has frequently noted inability to fully complete the act of inspiration during an attack of digestive discomfort. Other symptoms observed include anorexia, occasional vomiting, epigastric distress, headache, general malaise, subnormal temperature and low blood pressure. Gaultier mentions pain in the region of the umbilicus rather than in the epigastrium appearing two hours after meals in the form of par-

oxysmal colic accompanied with occasional vomiting and alternating constipation and diarrhea.

The gastric test meals may show an excess of free hydrochloric acid but more frequently it is diminished or absent.

The duodenal test meals may reveal diminished activity of the pancreatic ferments. A trace of blood is frequently observed with the thread or braid test.

The *x*-ray findings are not diagnostic but may reveal duodenal dilatation and stasis or an apparently contracted duodenum. The diagnosis will depend upon investigations made with the duodenal tube following Lyon's procedure, i.e., after the stomach is thoroughly cleansed and an astringent used to temporarily check the activity of the gastric mucosa, the duodenum is intubated and the contents aspirated before and after lavage.

The specimen will contain stringy mucus, epithelial cells, leucocytes, erythrocytes and bacteria. The presence of bile may make it impossible to rule out the bile tract as a source of the abnormal products although the character of the epithelium may give a clue.

SIMPLE ACUTE DUODENITIS

It is this form which most commonly complicates infectious fevers, gastritis and gastroenteritis. It may shade gradually into the ulcer type. There is, however, a group in which the duodenitis does not suggest ulcer. The pathology has not been so definitely described as in the ulcer type but Lesage describes an intense violet color of the mucosa covered with small granulations and distended venules.

The symptoms are similar to those of chronic duodenitis but are more acute. They may be referred to the stomach and consist of nausea, vomiting, distention, eructations and regurgitation. The vomitus may contain bile. There may be digestive pain but it is less definitely associated with food than is the pain of ulcer and may simulate cholecystitis.

Frequently there is a distressing sensation and fullness in the upper right quadrant of the abdomen that usually reaches its maximum intensity several hours after eating, according to Blankinship and Oatway.

Blocking of the papilla of Vater leads to painless jaundice and occasionally to pancreatitis. The stomach may be involved in the inflammatory process. Diarrhea is not uncommon. The temperature may be normal or slightly raised. Traces of blood may be obtained with the thread or braid test.

Aspiration of the duodenal contents gives less definite information than in the chronic form because of the frequent involvement of the stomach. If this can be eliminated the products of duodenal lavage will resemble those of chronic duodenitis.

ULCER TYPE OF DUODENITIS

This variety may run an acute or chronic course. In cases studied by Judd and Nagel the clinical picture was practically identical with that of peptic ulcer.

The lesion may not be demonstrable until the mucosa is exposed or may cause a general doughy thickening of the involved segment, a frequent observation in the writers' experience. It may involve a considerable portion of the duodenum or only a small area close to the pylorus.

The reaction varies from congestion to infiltration of the mucosa and muscularis and the formation of shallow erosions.

Judd and Nagel distinguish (1) a mild form with slight edema, hyperemia and faint stippling upon rubbing of the serosa, usually located on the anterior surface just beyond the pylorus; there is no deformity of the duodenum but there may be pylorospasm; (2) a more advanced form in which the area is red, hyperemic and edematous with marked stippling of the serosa; (3) a still more advanced form in which the duodenum is narrowed over a considerable area. There may be deformity of the duodenum but no stellate scars, irregular contractions or punched-out le-

sions. They note a tendency to circular constriction of the bowel, but whether due to spasm or true narrowing, it is difficult to determine.

All stages of superficial ulceration may be seen from tiny abrasions to fissures and ulcers of considerable size. Microscopical examination shows "cellular destruction with congestion, edema and migration of polymorphonuclear leucocytes, lymphocytes and endothelial leucocytes" according to MacCarty. The epithelium may be intact or denuded and covered with fibrinous exudate. The glands of Brunner and Lieberkühn may be swollen and show cul-de-sacs filled with proliferated cells. The solitary glands are dilated.

There was a history of hemorrhage in approximately 25 per cent of 176 cases reported by Kirklin, Judd and Nagel, Hufford, Blankinship and Oatway. This consisted of both melena and hematemesis and in some instances was profuse.

Hufford finds the ulcer symptoms somewhat atypical. Flatulency shortly after food was common. Relief by food and alkalies was not as definite as in ulcer. Epigastric pain was often vague and delayed, its maximum intensity occurring from one to three hours after food, and pain referred to the back or chest was frequent. The pain is usually less definitely localized than in ulcer and may be diffused over the entire upper right quadrant of the abdomen according to Blankinship and Oatway. Nausea and vomiting were not infrequent. Hemorrhage occurred in about one-third of the cases and was often severe. In another group there was only slight epigastric distress at irregular intervals after meals but with periodic attacks of bleeding. Pylorospasm is frequent and it is not unusual to observe a diffused area of tenderness in the region of the duodenum. Apparently definite pyloric obstruction is unusual although pylorospasms may cause temporary gastric retention.

The free hydrochloric acid was usually high in the cases reported by Judd and Nagel but was absent in one case in which hemorrhage occurred.

Seventy-seven cases studied by Johnson showed normal secretion of hydrochloric acid in 30, over secretion in 25; diminished secretion in 22. The string test showed a blood stain in 40 per cent of these cases.

Among the complicating lesions were noted angulation of the duodenum, atony and ptosis of the stomach and duodenum, cardiovascular renal disease, vascular hypotension and hypertension, chronic appendicitis, gall-bladder disease, constipation, diarrhea, and hookworm infection.

In Johnson's series duodenitis was not always positively demonstrated, since he classified as duodenitis, cases in which there was no constant roentgenographic defect, but there was a tender, reluctantly filling and rapidly emptying duodenum with irregular spasmodic contraction which could be overcome by slight pressure.

This type of duodenitis may run its course with or without superficial ulceration and may lead to true peptic ulcer according to Hufford. When ulceration occurs the symptoms become more definite.

Carman found that the roentgenographic deformity resembled that of ulcer except for the absence of a niche. Kirklin describes marked irritability of the bulb which tends to empty quickly but incompletely.

> As a rule the bulb is small and grossly deformed by deep indentations and its borders are less sharply defined than in cases of true ulcer, in, that a marginal niche or central fleck cannot be seen and it does not cause gastric retention. . . . The irritability of the bulb is characterized by writhing and rapid emptying making it difficult to fill the bulb for any length of time. . . . Positive differentiation from frank ulcer is not feasible and it might be confused with reflex spasm of the bulb.

The following evidence is suggestive if not conclusive: a tender, reluctantly filling and rapidly emptying duodenum; irregular spasmodic contraction overcome by slight pressure; absence of a constant roentgenographic defect.

PHLEGMONOUS DUODENITIS

Phlegmonous duodenitis is a rapidly advancing infection involving particularly the submucosa and leading to suppuration.

It does not differ in pathology from phlegmonous inflammation of the stomach and of the remainder of the intestinal tract but is relatively rare.

Frising and Sjövall in 1913 reported 183 cases of phlegmonous gastritis collected from the literature.

The writer has found reports of only 16 cases of phlegmon of the duodenum, one of them involving the stomach and entire intestinal tract.

Moser has reported 4 cases of pyolymphangitis and duodenitis following impaction of a gallstone in the papilla. These are not cases of true phlegmon of the duodenal wall but purulent lymphagitis in the hepatoduodenal ligament.

Anthrax of the duodenum resembling phlegmonous duodenitis has also been described.

A study of the true cases, because of their small number, affords statistics of limited value.

Ten patients were male and 4 were female. The ages ranged from twenty-one to eighty. Twelve patients were over fifty years of age. The duration of the illness ranged from one to forty days. Additional pathology consisted of dilated bile ducts, diverticula, enlarged glands, a fishbone in the duodenum, and bone splinters in a diverticulum. The bacteria found consisted of: B. coli, staphylococci and streptococci. Jaundice occurred in 2 cases.

Infection occurs primarily in the mucosa and extends to the submucosa according to Goldschmidt.

A definite cause could be found in only a small percentage of cases. None of these was secondary to ulcer or to ulcerating carcinoma as has been found in phlegmon of the stomach.

In one instance a fishbone was imbedded in the wall of the duodenum (Taylor and Lakin) and in another fishbones were found free in the lumen of the gut (Frising and Sjövall).

Three cases were attributed to the presence of diverticula and in one Ungermann found a diverticulum that contained splinters of bone; in another the inflammation was most marked in the vicinity of the diverticulum. It is logical to conclude that, as in the appendix or a Meckel's diverticulum, stagnation of the contents may cause lesions of the epithelial layer which serve as a portal of entry for infection.

In 2 cases reported by Frising and Sjövall and in one by MacCallum, there was chronic gastritis and diminution in the secretion of hydrochloric acid and the former point out that the loss of antiseptic power in the gastric juice removes a barrier against infection.

Schneider notes that in several of the reported cases there was cirrhosis of the liver and assumes therefore that such patients are predisposed to intestinal phlegmon.

The onset is always sudden with early grave impairment of the general condition.

The clinical picture is not characteristic.

In 2 cases there were symptoms of fulminating peritonitis, one with jaundice; one was diagnosed as high intestinal obstruction, one as pancreatitis and two as appendicitis. One ran a chronic course with symptoms of obstructive jaundice.

A correct diagnosis is difficult. The onset of peritonitis in the epigastric region is suggestive but more frequently follows perforation of gastric or duodenal ulcer. In the absence of peritonitis and fever, severe epigastric pain, profuse bilious vomiting, palpable tumor, muscular resistance and an area of tenderness may suggest pancreatitis.

TREATMENT

In the chronic, acute and ulcer types attention should be given to general hygiene. Alcohol, tobacco and carbonated drinks should be avoided. All sources of

infection should be eliminated and complicating lesions controlled.

Gastric secretion should be regulated for hydrochloric acid in excess is an irritant and its absence favors infection. Atropine or belladonna is useful to allay spasm and irritation and bismuth with or without alkalies is soothing.

In chronic or subacute forms, direct treatment may be useful, transduodenal irrigation as suggested by Jutte, duodenal lavage and instillation of various silver salts.

Symptoms suggestive of ulcer require ulcer treatment. Medical treatment should be tried but persistence of symptoms indicates the need of surgery. Judd and Nagel consider their pyloroplasty the most suitable procedure but with extensive involvement of the duodenum, resection may be required.

In phlegmonous duodenitis the treatment will be limited to incision, packing, and drainage of the area involved, possibly supplemented with jejunostomy for feeding as was done successfully by v. Mikulicz in a case of phlegmonous gastritis.

In all reported cases of duodenal phlegmon the patients have died.

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PYLORIC OBSTRUCTION

A ROENTGENOLOGIC STUDY*

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PYLORIC obstruction is not an uncommon affection and is frequently disclosed in the routine investigation of the gastrointestinal tract. A gastric retention of the contrast meal between fifteen and twenty-four hours is considered as evidence of pyloric obstruction. However, gastric retentions of longer periods have been observed, and in one instance in our study, barium was found retained in the stomach for ten days. It is not unlikely, however, that in some instances a gastric retention of even longer periods may be encountered. A six-hour gastric residue is not necessarily indicative of an organic pyloric obstruction and is not included in this presentation.

The necessity for a study of this subject has become increasingly evident, especially from a roentgenologic standpoint, inasmuch as in many instances this condition is not suspected until discovered by the roentgenologist. It has thus appeared to us that this subject should be more thoroughly investigated, and for that purpose this communication attempts to point out certain roentgenologic findings, which have impressed us as highly important in arriving at the diagnosis and determining the etiology of this condition.

In a survey of approximately 10,000 gastrointestinal roentgen examinations, it was found that 125 cases, or slightly over .01 per cent, presented evidence of pyloric obstruction. On the other hand, of all organic lesions which occurred at the pyloroduodenal outlet, it was found that approximately 10 per cent revealed this complication. This high percentage of instances revealing evidence of pyloric obstruction is considerably greater than might be inferred from a survey of the literature.

The roentgen diagnosis of well-marked gastric retention is exceedingly simple, but even here the true nature of its etiology is at times most obscure. A most painstaking study is often required in order to arrive at a correct conclusion regarding the significance of gastric retention and its primary cause. On this account, in the course of a roentgen examination one of the most essential steps is meticulous inspection of the pyloric outlet. In no other condition of the stomach is this of greater importance.

ETIOLOGY

In most instances a gastric retention indicates an organic lesion at the pyloric outlet. It is interesting to note that the etiology of this complication varies considerably, but in the majority of instances ulceration or carcinoma are the principal causes. The following conditions were found to be responsible for this complication: (1) pyloric ulcer, (2) pyloric carcinoma, (3) pyloroduodenal ulcer, (4) duodenal ulcer, (5) duodenal stenosis, (6) adhesions, (7) syphilis, (8) hypertrophic stenosis, (9) spasm, and (10) extrinsic pressure.

Roentgenologically the degree of obstruction is estimated by the amount of retention. It occurs as a trace, is small, moderate, or marked, depending upon the relative amount of barium retained in the stomach. In my series of 125 cases, there was marked retention in 56, moderate in 30, small retention in 14 and traces were observed in 25 instances. It is of interest to note that the amount of gastric retention

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is not a significant factor as evidence pointing to the nature of the pathological lesion present.

of this condition due to ulceration or carcinoma, verified by operation, it was observed that of 17 cases of carcinoma, 14

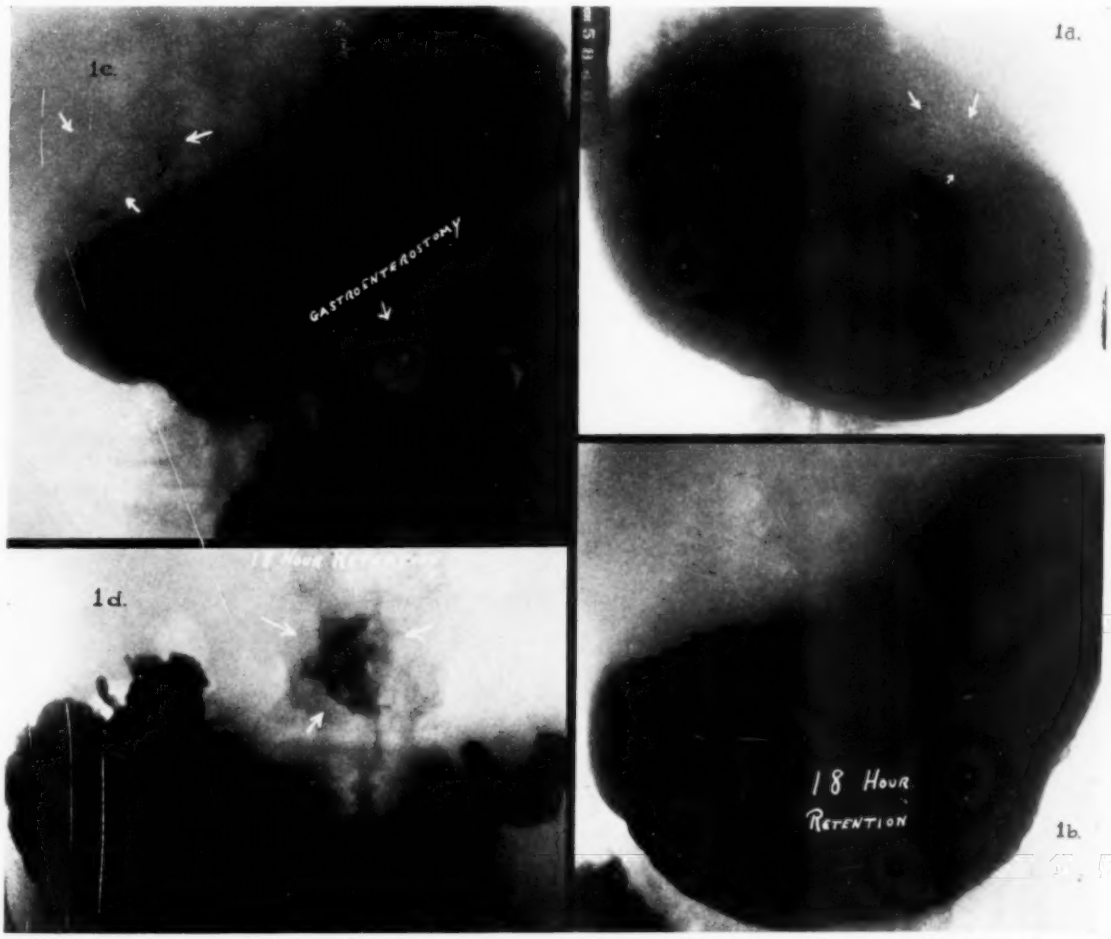


Fig. 1. A. Case of pyloroduodenal ulcer with moderate dilatation of stomach (size reduced). Note obstructive lesion at pyloroduodenal outlet, involving pylorus and duodenum. B. Amount of gastric retention in eighteen hours. C. Pyloroduodenal ulcer filling defect is more clearly visualized at arrows. Posterior gastroenterostomy was performed and pyloroduodenal ulcer found. D. Small (trace) gastric retention, following gastroenterostomy.

In this study, the size of the stomach, when filled with two glassfuls (500 c.c.) of barium meal, was determined and accordingly was held to be either normal or dilated. Of the 125 cases with gastric retention, the stomach was found to be dilated in 69 and normal in 56. According to many observers, the view has been frequently expressed that a dilated stomach is more apt to be due to a benign obstruction and that a non-dilated stomach when obstructed is more apt to be of malignant nature, but this is certainly not borne out by this study. For in a group of 36 cases presented evidence of dilatation and in 3 dilatation was not present; while in 20 cases due to ulcer, 14 were found dilated and in 6 the size of the stomach was normal. These findings clearly indicate that there is no direct evidence for the assumption that a dilation of the stomach is more apt to be due to a benign lesion.

From a roentgenologic point of view, it is often difficult to state definitely whether or not a given case of pyloric obstruction is benign or malignant, unless there is a characteristic filling defect indicating the type of lesion. It must be emphasized,

however, that a classical filling defect is not always observed in this complication and that roentgenologically it is more

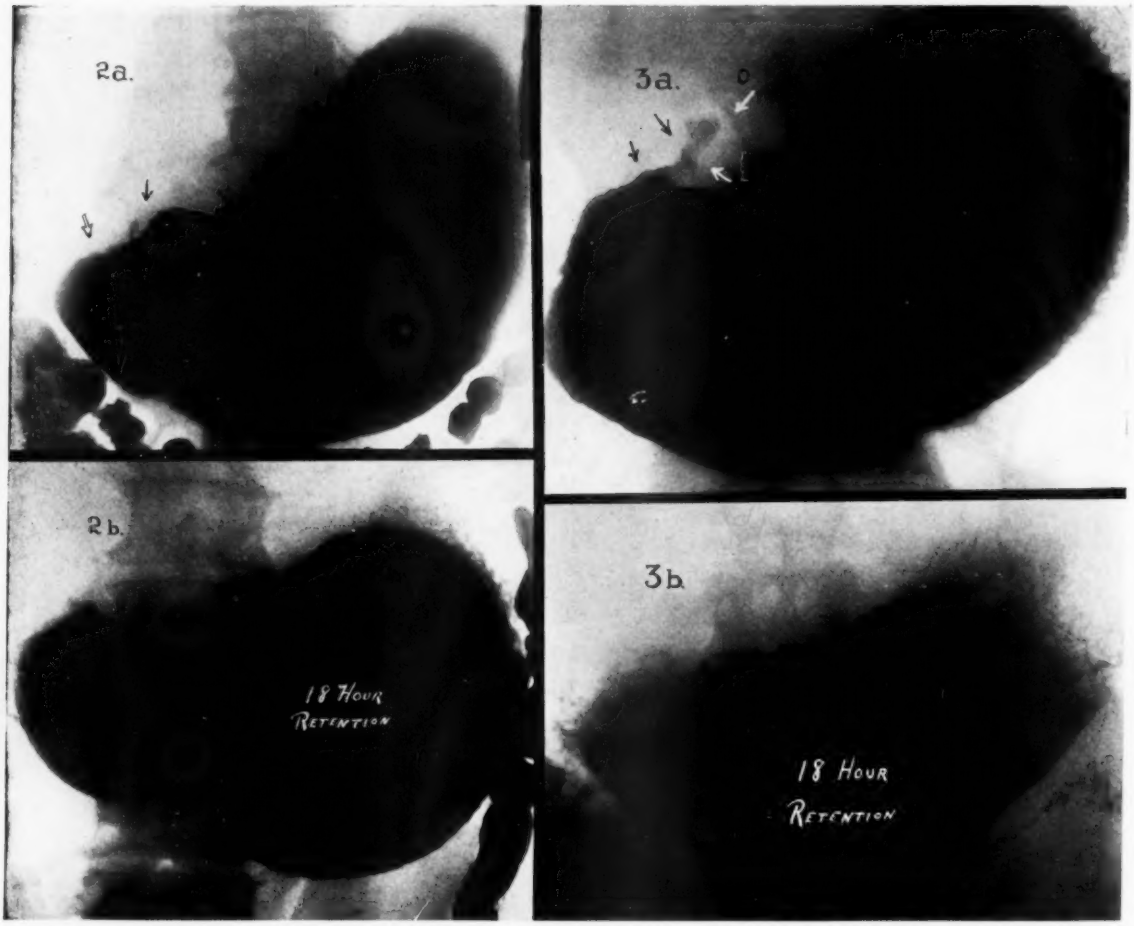


Fig. 2. A. Case of pyloric obstruction, with marked dilatation of stomach (illustration 1/6 natural size). No characteristic filling defect of either ulcer or carcinoma is shown, but clinically proved to be a case of pyloroduodenal ulcer.

B. Large gastric residue (full size).

Fig. 3. A. Case of pyloroduodenal ulcer. Stomach is moderately dilated (illustration 1/3 natural size). Note filling defect at arrows, illustrating involvement of pylorus and duodenum.

B. Amount of gastric retention in eighteen hours (full size).

in 10 instances. It is interesting to observe that in this group of 125 cases but 73 were determined roentgenologically as being either due to ulcer or carcinoma. Of special interest are the 37 cases in which no etiologic factor could be determined. These were placed in the obstructed group of organic nature of undetermined origin, as it was impossible, at least from a roentgenologic standpoint, to state definitely whether or not they were benign or malignant. Sufficient roentgen evidence is not always at hand to arrive at an exact diagnosis, inasmuch as no classical *x*-ray picture can be demonstrated in many instances. However, in doubtful cases with marked

expedient in such instances to report these cases as obstructive pyloric lesions of undetermined nature.

In this study the roentgen examination revealed the following findings: Pyloroduodenal ulcer was observed in 37 cases, carcinoma in 26, pyloric ulcer in 8, pyloric lesion undetermined in 35, gastric ulcer with pyloric cancer in 2, gastric ulcer with pyloric ulcer in 1, gastric ulcer with pyloric lesion in 2, duodenal stasis and duodenal adhesions in 3, pressure from a retroperitoneal sarcoma in 1, and no organic lesion

dilatation, the history presenting a long course of gastric disease is frequently of importance in the differential diagnosis and may point to the primary cause of the obstruction.

COMPARATIVE OPERATIVE AND ROENTGEN STUDIES

A study made of 40 operative cases presenting evidence of pyloric obstruction was compared with the *x*-ray findings and yielded the following data:

	Operative Cases
Ulcer	17
Carcinoma	18
Adhesions	3
Gall bladder lesion	1
Retroperitoneal sarcoma	1
	40

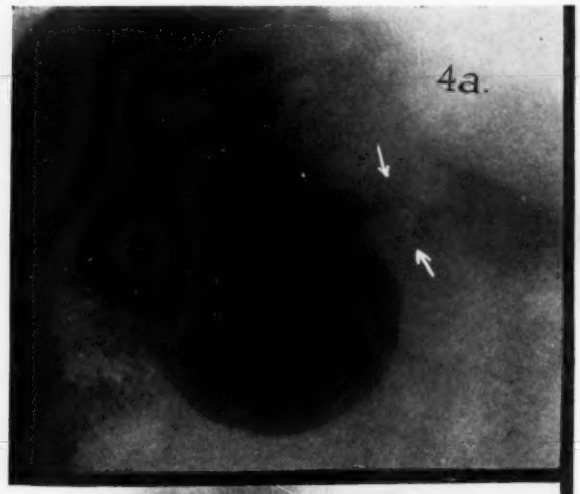
	Roentgen Diagnosis
Ulcer	11
Carcinoma	11
Adhesions	1
Gall bladder lesion	1
External pressure	1
Pyloric lesion, undetermined	15
	40

It may be concluded from this study, that in the greater proportion of cases of obstruction, definite organic pathology involving the pyloric outlet occurs. Of the 40 operative cases, 35 lesions were produced by either ulcer or carcinoma, while the remaining 5 were caused by other conditions. It will be noted that from a roentgenological point of view, there were a large group of cases in which the etiologic factor could not be established. There were 15 such instances in this group. While this comparative study therefore discloses the fact that it is difficult at times to determine the nature of the lesion by this method of examination, nevertheless the roentgenologist may be able to present important data which, when considered with clinical and laboratory findings, are often helpful in arriving at a correct diagnosis. The roentgenologist may necessarily have to content himself with recording the presence of an obstructive lesion, for at times it may be impossible to state its exact cause. The failure to recognize the primary cause of the obstruction, however, is due to the fact that frequently no classical pathognomonic filling defect characteristic of the lesion is presented. This is often due to the difficulty encountered in obtaining the proper filling of the involved area, because of stenosis preventing the visualization of that portion of the pylorus distal to the obstruction. The more complete the obstruction, the greater and increasingly more difficult is visualization of the entire involved area. A filling defect when observed may not always reveal the typical appearance of malignancy. Presented therefore with a case of pyloric obstruction, the roentgenologist is often requested to give his opinion as to whether or not the condition is benign or malignant. This is at times most difficult to determine with certainty. The diagnosis must in many instances rest upon a clinical basis and finally with the surgeon or pathologist.

It is noteworthy to point out that, as a rule, taking the law of averages as a working basis, if an obstructive lesion is visualized and involves only the pylorus, but does not extend beyond the pyloric sphincter, the condition should be considered roentgenologically as possibly malignant, regardless of the size of the stomach. On the other hand, if the filling defect is observed to cross the pyloric sphincter and involve the duodenum, the lesion is more apt to be benign. This rule, although found to be correct in most instances, is also not without error, for at times the lesion may be simulated by other conditions and the greatest caution should be exercised in interpreting these findings.

Pyloric obstruction due to a simple uncomplicated duodenal ulcer is not a common finding. In nearly every instance in this series, pyloric involvement was also noted. In several cases, duodenal adhesions accounted for a slight twenty-four hour gastric retention. In these a duodenal stasis was observed.

Obstructive lesions of the pylorus may be simulated by other conditions, such as spasm, adhesions and from extrinsic pressure. In one instance a retroperitoneal sarcoma was found, the stomach being otherwise entirely normal. In the 3 remaining cases no



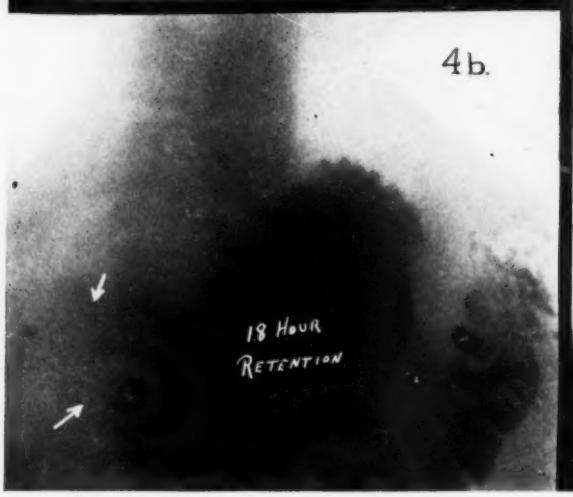


Fig. 4. A. Annular pyloric carcinoma, with a palpable mass. Stomach not dilated (illustration ⅓ natural size). Confirmed at operation.

B. Eighteen hour gastric retention. Note characteristic carcinomatous filling defect at arrows.

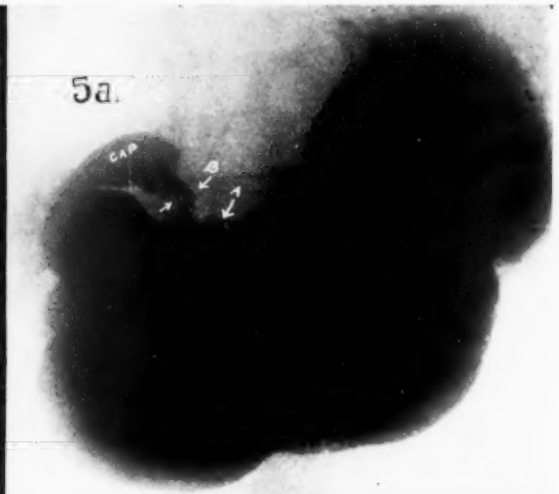


Fig. 5. A. Case of pyloric ulcer, proved at operation. Shows slightly large stomach with penetrating ulcer filling defect on lesser curvature at A. and an annular lesion at B. Duodenal cap is not involved.

B. Same case; moderate eighteen hour gastric retention.

sure. It is interesting to note that in a number of instances in this series no pathological lesion could be detected in the pyloroduodenal area to account for the gastric retention.

TUMOR MASS

Of 97 cases, there were 13 which revealed a distinct palpable mass. These were detected fluoroscopically with the palpating hand. Of these patients 10 were operated upon; 9 of the cases revealed carcinoma. In operation was performed. A tumor mass is not always observed, but when present is the most reliable objective sign of malignancy, though at times a syphilitic lesion, a benign growth, an inflammatory mass or extrinsic tumors may simulate this finding.

SEX

In this series of 125 cases there were 92 males and 33 females. The preponderance of males (ratio of almost 3 to 1) with this complication is very significant.

AGE

The following table illustrates the age of patients in whom pyloric obstruction was demonstrated.

Age	Cases
1 to 6 months	2
1 to 10 years	0
10 to 20 years	2
20 to 30 years	11
30 to 40 years	21
40 to 50 years	26
50 to 60 years	36
60 to 70 years	17
70 to 80 years	10
	125

It will be noted that the majority occurred between the ages of thirty and seventy and that the greatest number occurred in the fifth decade.

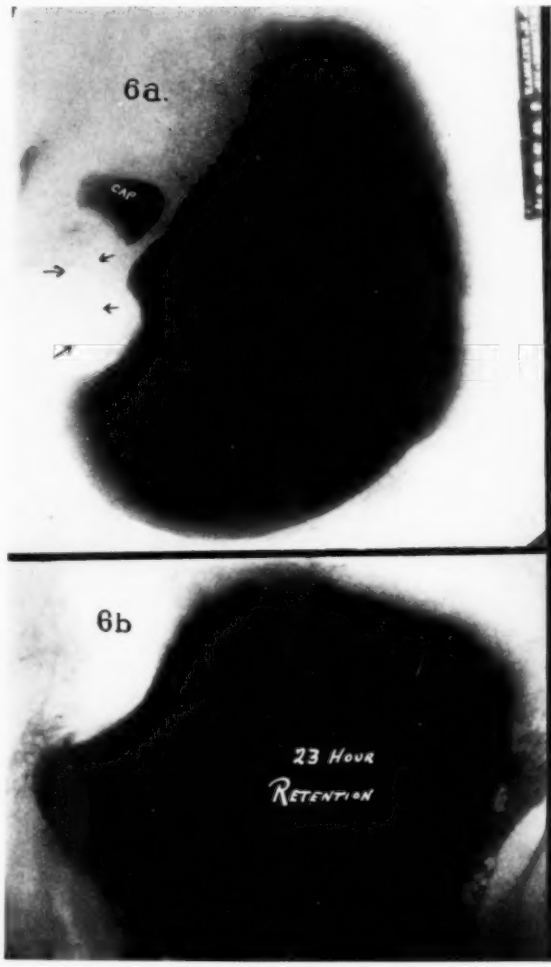


Fig. 6. A. Huge stomach (illustration 1/6 natural size) with large annular carcinoma of pylorus. Large mass was palpated over defect area. Duodenal cap was not involved. This case presented a clinical course of carcinoma.

B. Same case; large twenty-three hour gastric retention.

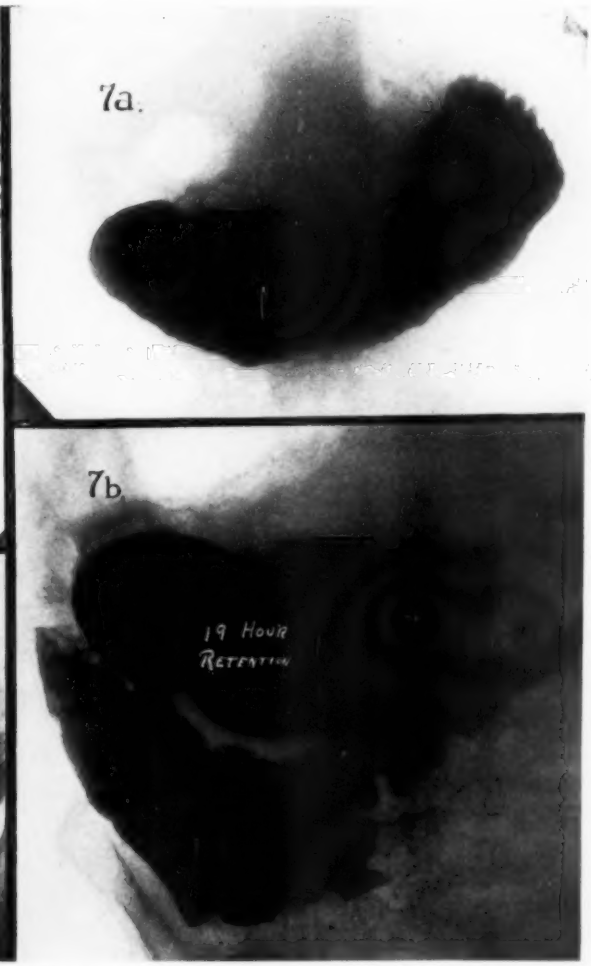


Fig. 7. A. Long transverse stomach without dilatation (illustration 1/6 natural size). In one hour none of contrast meal was observed to pass through pylorus. Pyloric obstruction was evident, but on account of difficulty encountered in obtaining proper visualization beyond point of obstruction, etiology could not be definitely established, although roentgen and preoperative diagnosis was that of carcinoma. This case proved to be due to a carcinoma.

B. Same case, showing nineteen hour gastric retention.

WASSERMANN REACTION

There were 58 Wassermann tests made in the entire series. Of these 54 were found to be normal and 4 were positive. In only 2 instances, however, was the obstruc-

tive lesion considered to be of syphilitic origin.

CONCLUSIONS

1. Pyloric obstruction is not an uncommon complication. It was found in slightly over .01 per cent of all gastrointestinal roentgen examinations and in approximately 10 per cent of all organic lesions involving the pyloroduodenal outlet.

2. Roentgenologically it is not always possible to distinguish between an ulcer and carcinoma in cases of pyloric obstruction.

3. Gastric dilatation and the degree of gastric retention cannot be considered as an aid in the differential diagnosis between ulcer and carcinoma.

4. There is no roentgenologic basis for the assumption that a dilated stomach is more likely to be due to a benign obstructive lesion or that an obstructive normal sized stomach may be due to a malignant disease.

5. The presence of a tumor mass is an important sign of malignancy, but this too is not always demonstrable.

6. The roentgen examination, though extremely important in the diagnosis of this complication, must be considered together with other factors in order to establish the final diagnosis.

POSTOPERATIVE VISUALIZATION OF THE BILIARY SYSTEM WITH RADIOPAQUE OILS

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DIRECT roentgenologic visualization of the biliary system by means of radiopaque material, aside from cholecystography, has been extremely rare until recently. Usually it has been an accidental finding in the course of the routine barium meal examination.[1,2,3] In the occasional case where barium had entered the common bile duct the following causes were noted: (1) accidental or unexplainable regurgitation from the duodenum; (2) carcinoma of the ampulla; (3) internal biliary fistula[1,4,5]; (4) common duct stones.[6]

An early attempt to visualize the biliary system roentgenologically was by means of the injection of persistent postoperative biliary sinuses.[7,8] It can at once be seen that valuable information can be secured by such means. Although the exact cause of persisting postoperative obstruction such as incomplete removal of common duct stones, operative injury to the choledochus with stenosis, and slowly developing obstructive neoplasms located at the head of the pancreas or in the periportal lymph glands, cannot be accurately differentiated, still the information thus obtained in conjunction with the clinical picture often suffices to make accurate diagnosis possible.

More recently radiopaque solutions have been used to study the biliary system following surgical operations.[9–13] Cholecystostomy tubes and T-tubes in the common duct, injected postoperatively with radiopaque solutions, give valuable information regarding the postoperative status of the biliary system. It can be demonstrated whether or not biliary obstruction has been relieved, and if there were any stones in the common duct, whether or not they have all been removed. It is probably the most valuable single procedure which we have in determining how long a T-tube should remain following drainage operation on the common duct for stones, stricture or whatever cause.

The study of the literature along this line demonstrates the true value of the procedure, and there are very few cases reported in which the biliary system and one of the pancreatic ducts, probably the main one, have been clearly visualized. Such a case is included in those reported in this paper.

METHOD OF INJECTION

From 15 to 20 c.c. of lipiodol were used with the patient on the fluoroscopic table. The lipiodol was slowly injected by means of a syringe. We did not use the gravity method as recommended by Overholt and others. The tube was clamped after the injection and a scout film taken. If the film proved satisfactory, usually stereoscopic roentgenograms were taken. Our reason for the use of the injection method was that much better visualization of the biliary system was obtained. No untoward effects were noted with any of the injections.

REPORT OF CASES

CASE 1. A woman, aged fifty-eight, was brought to the hospital at 2:30 P.M., December 22, 1930. She had had three definite attacks of colic in the upper abdomen, followed by jaundice, within the last three months. The present attack started more than twenty-four hours before and had been increasing in severity. She was moderately jaundiced. Just after eating dinner she had a spasmodic attack of pain which caused her to vomit. The pain was located in the epigastrium, slightly to the right of the median line, and radiated through to the back. The patient stated that her urine was very dark and her stools light colored. The temperature was 101°F. and the

pulse rate 90. The pain was so severe as to require morphine.

General examination showed a markedly obese woman, moderately jaundiced. There was rigidity in the upper right quadrant with extreme tenderness. The liver was enlarged and its border palpable beneath the costal margin.

Fig. 1. Case I. Lipiodol injection into T-tube in common bile duct: 1, T-tube; 2, common duct; 3, duodenum; 4, biliary radicles.

The blood showed hemoglobin 82 per cent (Dare), red blood cells 5,720,000, and leucocytes 11,400. Chemical examination of the blood revealed nonprotein nitrogen 42.0 mg., chlorides 470 mg., and blood sugar 120 mg. for each 100 c.c. of blood. The Wassermann reaction was negative. The blood coagulation time was five minutes. The urine contained bile but no other abnormal constituents.

The patient was hospitalized and given an injection of 600 c.c. of Ringer's solution and 200 c.c. of 20 per cent glucose intravenously. Operation six hours later revealed a gangrenous gall bladder containing three stones impacted in Hartmann's pouch. There was a surrounding acute inflammatory reaction accompanied by a seropurulent exudate and old and recent adhesions. The common duct was dilated and its wall thickened. The head of the pancreas was diffusely nodular. The gall bladder was removed, the common duct opened and washed out with a catheter and warm saline solution. Only biliary sand was found. Saline solution could be easily injected through the common duct into the duodenum. A T-tube was inserted into the common bile duct and one other drainage tube was placed in the wound.

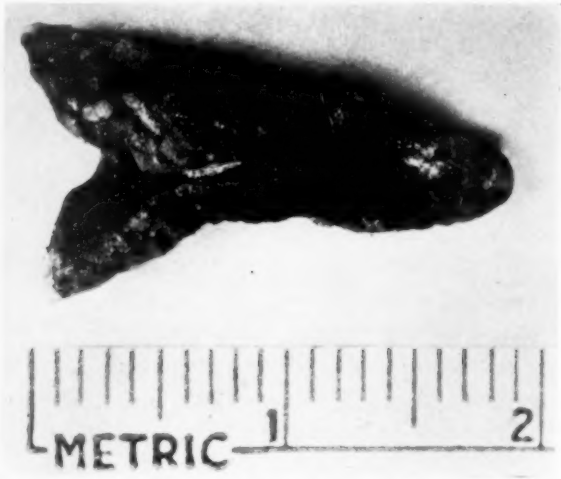

Fig. 2. Case IV. Branched stone removed from junction of hepatic with common bile ducts.

The convalescence was stormy for the first forty-eight hours. The patient was kept for seventy-two hours in the Roth-Barach oxygen tent (the first oxygen tent devised by Roth was in use in the Sanitarium Hospital in 1920). There was only a small amount of bile drainage the first forty-eight hours. After that the drainage was free and from 7 to 14 oz. a day came through the T-tube. The patient's jaundice cleared up quite rapidly. Improvement was gradual but steady until the twelfth day postoperatively when a suppurative right parotitis occurred. This was opened and drained and thereafter convalescence was uneventful.

On the nineteenth day lipiodol injection of the T-tube was carried out and an *x*-ray study showed the common duct emptying freely and rapidly into the duodenum (Fig. 1).

Case II. A woman, aged fifty-three, was admitted to the hospital February 28, 1932. The principal complaint was pain in the region of the gall bladder associated with jaundice. The patient could recall having had a sore spot in the right upper quadrant of the abdo-

men for at least three years, but during the past year the symptoms had increased in severity and frequency. She said she had had

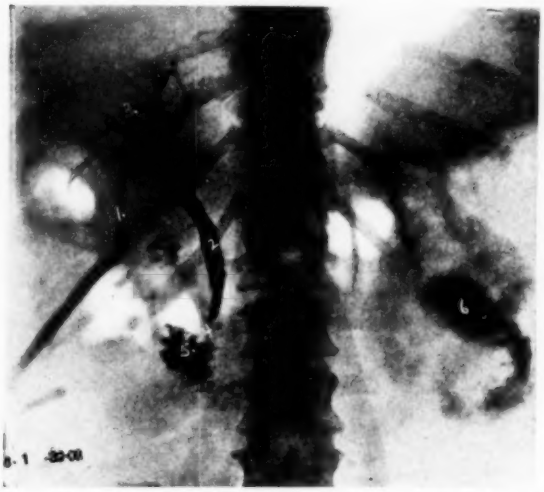

Fig. 3. Case IV. Injection of T-tube in common bile duct showing ampulla of Vater (4). 1, T-tube; 2, common bile duct; 3, biliary radicles; 4, ampulla of Vater; 5, lipiodol in duodenum; 6, lipiodol in jejunum.

Fig. 4. Case IV. First of stereoroentgenograms following injection of 20 c.c. lipiodol into T-tube in common bile duct. Note pancreatic duct (5). 1, T-tube; 2, common bile duct; 3, biliary radicles; 4, ampulla of Vater; 5, pancreatic duct; 6, duodenum.

a number of attacks of distressingly sharp pain which she described as a "continuous agony," and which lasted several days and nights. These attacks required the attention of a physician. Her last attack began a week before admission, Wednesday, February 24. It started with nausea, "sickness in the stomach as well as the back," and some pain. Later the pain became very severe and continuous, and the abdomen was just "one vast bag of misery," and this pain did not stop. She could take only short breaths. She repeatedly vomited large quantities of bile, and there was an immense amount of gas. She also had diarrhea during the present attack.

General examination showed an obese woman who looked older than her age. She was slightly jaundiced. Pressure over the upper abdomen disclosed tenderness in the region of the liver, and in the right epigastrium. The liver was enlarged. There was a definite resistance in the right upper quadrant of the abdomen. She was very tender in the back on both sides.

The blood showed hemoglobin 80 per cent (Dare), red blood cells 4,280,000, and leucocytes 6000, with a differential count of 72 per cent polymorphonuclear neutrophils, 1 per cent eosinophils, and 27 per cent small lymphocytes. The non-protein nitrogen was 26.2 mg. and the blood sugar 100 mg. for each 100 c.c. of blood. The Kolmer-Kahn reaction was negative. The blood coagulation time was six minutes. The urine contained bile in moderate concentration.

At operation an acutely inflamed gall bladder was disclosed with a single stone impacted at the outlet. A simple cholecystostomy was done. The common duct could not be exposed without extensive dissection which was not considered advisable at this time.

Convalescence was uneventful. There was free drainage of bile from the beginning with rapid improvement in the jaundice. Lipiodol injection of the tube was carried out twelve days postoperatively and showed the common duct open, the lipiodol emptying immediately into the duodenum.

Case III. A man, aged forty-one, was admitted March 3, 1932. The patient had been observed at his home in conjunction with an internist for some weeks. The diagnosis was acute cholecystitis with moderate hepatitis. Following medical treatment he improved for a time and then had an exacerbation with more serious symptoms which finally demanded urgent surgical treatment. The patient had acute pain in the right side with rigidity of the right rectus muscle. It was possible to

palpate at times during his illness a distended gall bladder.

The blood showed hemoglobin 102 per cent

Fig. 5. Case iv. Second stereoroentgenogram. Note that pancreatic duct has emptied. 1, T-tube; 2, common duct; 3, biliary radicles; 4, ampulla of Vater; 5, duodenum.

(Dare), red blood cells 4,970,000, and leucocytes 15,600, with a differential count of 52 per cent polymorphonuclear neutrophils, 4.5 per cent eosinophils, 2 per cent basophils, 1 per cent transitional, 37 per cent small lymphocytes and 3.5 per cent large lymphocytes. The non-protein nitrogen was 39.1 mg. and the blood sugar was 120 mg. for each 100 c.c. of blood. The urine findings were negative.

Operation was carried out under lumbar anesthesia. The liver was the seat of an extensive hepatitis. The gall bladder was surrounded by recent acute omental adhesions. Because of the acute nature of the illness and the degree of hepatitis it was thought best to do a simple cholecystostomy. Several ounces of purulent bile were removed by suction. No stones were discovered in the common or cystic ducts but satisfactory palpation of the common bile duct could not be carried out owing to the inflammatory nature of the upper abdomen with the adhesions surrounding the head of the pancreas.

The patient had a stormy forty-eight hours but following this his convalescence was smooth. There was only a small amount of cloudy bile the first twenty-four hours. This rapidly increased in volume and became dark brown in color. The patient was discharged and went to his home on the seventeenth day. The tube was removed at the end of three weeks.

Lipiodol injection was carried out eighteen days postoperatively and there was not found to be any obstruction of the cystic duct or the common bile duct, the lipiodol rapidly passing through into the duodenum.

Case iv. A man, aged forty-seven, was seen by Dr. Cooper April 3, 1932. His leading complaint was jaundice with generalized pruritus. The jaundice had come on without pain six months before. The patient had lost 20 pounds in weight. There was failure of appetite. He had clay-colored stools and highly colored urine. The gall bladder had been removed five years previously following which the patient had remained well four and one-half years.

General examination revealed a large man weighing 215 pounds. He was extremely jaundiced. Nothing abnormal was discovered on abdominal examination except the old gall bladder incision.

His blood showed hemoglobin 84 per cent (Dare), red blood cells 4,620,000, and leucocytes 9300. The Kolmer-Kahn reaction was negative. The blood coagulation time was four and one-half minutes. No albumin or sugar was discovered in the urine but there was considerable concentration of bile. The diagnosis was thought to be either common duct stone or neoplasm causing obstructive jaundice.

At operation, carried out May 18, 1932, under lumbar anesthesia, a calculus was discovered at the junction of the right and the left hepatic ducts with the common bile duct. The common duct was opened and a branched calculus (Fig. 2) was removed. The arms of the branched stone extended into the right and the left hepatic ducts. No further stones were discovered. A T-tube was inserted into the common duct and the opening in the common duct closed around the tube with interrupted sutures.

There was free drainage of light-colored bile, which gradually became darker, around the T-tube as well as through it. About 8 ounces of bile a day drained through the tube. The stools became dark in color on the sixth postoperative day. The patient's jaundice was rather slow in clearing up, requiring about two weeks before the skin was clear.

The patient had a lipiodol injection on the twelfth day followed by *x*-ray examination. Figure 3 shows the lipiodol passing immediately into the duodenum and the jejunum. It shows the T-tube, the common bile duct, the biliary radicles and the duodenum and the ampulla of Vater with a suggestion of beginning filling of another duct. For this reason, 10 c.c. more of lipiodol were injected through the T-tube. Stereoscopic *x*-ray films were then taken; the first stereoroentgenogram showed the same picture as before and also visualized quite clearly one of the pancreatic ducts. However, in the few seconds that had elapsed between the taking of the first roentgenogram (Fig. 4) and the second (Fig. 5) the pancreatic duct had emptied. Our first reaction to the finding was that perhaps some obstruction of the common duct due to a stone further down in the ampulla was present. However, the following day lipiodol injection was carried out and it was not possible to visualize the pancreatic duct again. The subsequent behavior of the case was uneventful. The tube was clamped for three or four days at night following which the stools became normal and the T-tube was removed at the end of three weeks. The drainage of bile ceased within twenty-four hours. The site of the drainage tube healed almost immediately.

Fig. 6. Case v. Lipiodol injection into T-tube in common bile duct: 1, T-tube; 2, common duct; 3, duodenum; 4, biliary radicles. Note clubbed ends of biliary radicles indicating obstruction of biliary system of long standing.

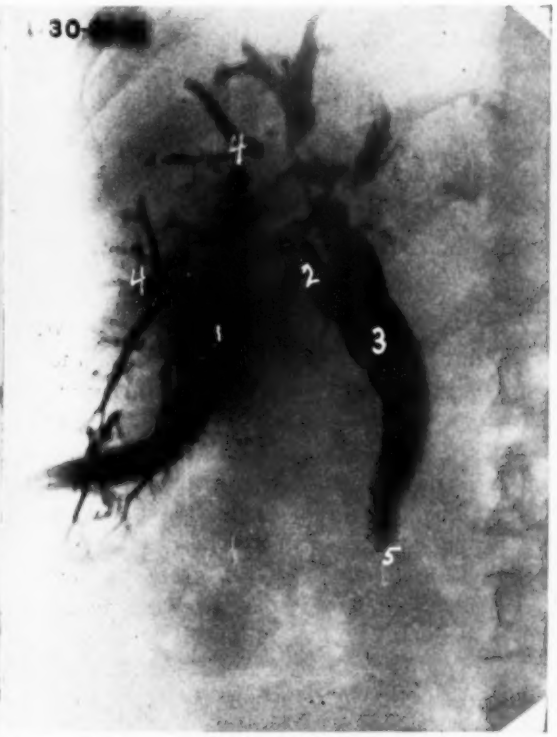

Fig. 7. Case vi. Injection of cholecystostomy tube with lipiodol. 1, Cholecystostomy tube; 2, cystic duct; 3, common duct; 4, biliary radicles; 5, site of obstruction, lower end of common bile duct.

Case v. A woman, aged fifty-nine, was admitted June 19, 1932, with a history of recurrent attacks of abdominal pain followed by jaundice. These attacks began several months ago. She has been afflicted with asthma for the past eight years. Radical sinus surgery carried out six months previous had given partial but not complete relief from the asthma.

Examination of the patient revealed marked tenderness in the right upper quadrant but there was no jaundice. No apparent enlargement of the liver or spleen could be made out. The gall bladder was not palpable. Cholecystography demonstrated numerous gallstones.

The blood showed hemoglobin 100 per cent (Dare), red blood cells 4,270,000, and leucocytes 11,400, with a differential count of 64 per cent polymorphonuclear neutrophils,

1 per cent eosinophile, 6 per cent transitional, 26 per cent small lymphocytes and 1 per cent large lymphocytes. The urine findings were negative.

Operation June 24, 1932 consisted of cholecystectomy under lumbar anesthesia. The common duct was explored by palpation but not opened. The postoperative convalescence from this operation was uneventful, but on September 27, 1932 she was back with recurrence of abdominal pain in a similar location, although there was more radiation through to the right side of the back. She also had frequency of urination with dysuria. Cystoscopic and pyeloscopic examinations were carried out. The bladder was normal and a shadow was demonstrated in the region of the right kidney, but it was the opinion of the urologist that it was extrarenal. In the next two and a half months, the patient had periodic attacks of extreme colic without jaundice and a diagnosis was made of common duct stone. A second operation was carried out on December 13, 1932. Lumbar anesthesia was used and the common duct was opened. One medium sized stone was found and removed. A small catheter was passed into the distal common duct and washed out with normal saline solution which passed readily into the duodenum. The proximal common duct was washed out with saline solution and there was no debris or sand present. A rubber T-tube was then placed in the common duct and was brought out through a stab wound external to the main incision.

Lipiodol injection of the common duct was carried out on December 27, 1932 and on January 4, 1933. Both series of *x*-ray studies demonstrated that the common duct was patent, the lipiodol flowed freely through from the duodenum (Fig. 6). The T-tube was left in place two days longer and then removed. The opening where the tube had been healed almost immediately and the patient has remained well without further attacks up to the present time, May 19, 1933.

Case VI. A man, aged fifty-two, was first seen at seven o'clock in the evening, April 16, 1933, with symptoms highly suggestive of acute appendicitis. A chronic cholecystitis was also suspected in his case as previous cholecystographic studies failed to visualize the gall bladder. Operation was carried out at 10:00 P.M. and a typical acute appendix was removed. Exploration of the gall bladder was carried out. There was a subacutely inflamed gall bladder with thickened walls, omental adhesions, moderate enlargement of the head of the pancreas and a diffuse hepatitis present. The gall bladder was opened, stones removed, and a cholecystostomy was carried out. His convalescence was smooth and on the tenth day lipiodol injection was carried out which resulted in the roentgen findings as recorded in Figure 7. There was no filling defect suggesting stones in either the gall bladder or the common duct. However, a complete ampullar obstruction was demonstrated, in spite of the fact that this patient had no jaundice before operation. As all of the symptoms indicated an obstructive lesion of the common bile duct and there was no cessation in the amount of bile draining externally, an average of about 20 to 30 ounces a day draining through the cholecystostomy tube, the patient was re-operated on May 4, 1933. The patient's general condition was such that it was not deemed advisable to carry out an extensive dissection of the common duct or transduodenal choledochotomy so a cholecystogastrostomy was carried out. The patient's convalescence has been smooth. Immediate aspiration of gastric contents following operation showed bile in the stomach and the stools have been dark in color since that time. Convalescence has been uninterrupted up to the present time.

DISCUSSION

Six cases of lipiodol injection into biliary surgical drainage tubes are presented to demonstrate the value of this procedure.

In 3 acute gall-bladder cases where it was only possible to carry out drainage operations on the gall bladder without exploration of the common duct the procedure demonstrated that there was no obstruction in the common bile duct in 2 cases and a favorable prognosis could then be given to the patient. In the other case where an ampullar obstruction was clearly demonstrated, the question of further operation could be taken up before the patient had left the hospital and relief of common duct obstruction could be carried out rather than have the patient return

to us or go elsewhere for relief of a persistently discharging biliary sinus.

In the first and fifth cases where surgical drainage of the common bile duct had been carried out, it was possible to demonstrate conclusively that there was no remaining obstruction in the common duct after operation.

In the fourth case the filling of a pancreatic duct might tend to give one the impression that there was an ampullar obstruction. However the rapid emptying of the lipiodol into the pancreatic duct and its rapid passage through the ampulla into the duodenum would rule out such a conclusion. Following the removal of the T-tube in this case the biliary sinus or stab wound for the T-tube closed within twenty-four hours and the patient has remained well and free from jaundice.

Clubbing of the proximal end of the biliary radicles is observed in cases where there is an extensive chronic hepatitis associated with ampullar obstruction.

CONCLUSION

Postoperative roentgenologic studies of the biliary tract with radiopaque oils are of great value in demonstrating whether or not success has been attained in choledochostomy. In cholecystostomy for acute lesions of the gall bladder, such studies will constitute the earliest indication for further surgery which may be carried out as a second stage operation before the patient leaves the hospital.

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SURGICAL EXPOSURE OF THE PANCREAS*

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WITH the advancement of our knowledge concerning diseases of the pancreas, exploration and surgical treatment of this organ are often indicated. Its deep situation across the posterior wall of the abdomen makes its exposure difficult.

Various methods of approach to the pancreas have been suggested in the literature. They offer many advantages and disadvantages. These methods were studied by me in a large number of cadavers. My conclusions based on anatomical grounds coincide in the main with present-day accepted technique.

ROUTES OF APPROACH

The pancreas can be reached either through an extraperitoneal or transperitoneal exposure.

Extraperitoneal (Posterior) Route. An incision in the right or left costovertebral angle can be made for drainage of a pancreatic abscess. This incision prevents contamination of the peritoneal cavity. It is a satisfactory route for free drainage when the abscess is localized posteriorly and a correct preoperative diagnosis has been made. The exposure given by this incision is not sufficient to study the extent and type of pathology present and, in addition, there is great danger of injury to adjacent important structures.

A cyst of the tail of the pancreas has been explored through the left oblique lumbar (kidney) incision.

The tail of the pancreas can be reached by an incision in the left loin commencing at the tip of the twelfth rib and extending obliquely forward to the umbilicus. This incision also has been used for the drainage of pancreatic inflammation. For exposure of the tail of the gland this is less advantageous than the transperitoneal route and is not even preferable for simple drainage.

Transperitoneal Route. Pancreatic swellings (cyst or abscess) have been drained through the most prominent and accessible part of the abdomen. This procedure is only justifiable in case of grave emergency because it does not enable the surgeon to ascertain the true pathological condition of the gland.

A two-stage operation in cases of pancreatic cyst has been advocated, the first stage being the suturing of the anterior wall of the stomach to the parietal peritoneum to wall off the general peritoneal cavity. In the second stage a vertical incision is made through the gastrocolic omentum, the cyst exposed and drained. This method has been used successfully by many surgeons.

The transgastric route for exposure of the pancreas has no advantages and is never indicated.

The pancreas is easily exposed in the performance of a gastrectomy. It is not uncommon to find dense adhesions between the posterior wall of the stomach and pancreas in gastric ulcer or carcinoma. Injury of the gland during separation of adhesions has caused many fatalities.

The head of the pancreas can be palpated through the foramen of Winslow.

Anteriorly the descending duodenum is covered by the posterior peritoneum which forms a mesentery to this organ. The posterior part of the head of the pancreas is exposed by a curved incision on the right lateral border of this mesentery. The duodenum is retracted upwards toward the midline by gentle stripping.

The same incision also exposes the lower end of the common bile duct. In 9 cadavers I was unable to find a distinct mesentery of the descending portion of the duodenum. A group of small veins behind the head of the pancreas may be torn and cause

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an annoying hemorrhage during its mobilization. Injury to the right kidney also should be avoided. This is an important exposure in pancreatic and biliary surgery.

The tail of the pancreas passes with the splenic vessels up into the hilum of the spleen and should be identified during exposure of the splenic pedicle. Injury to the tail of the pancreas has been reported during splenectomy.

Exposure of the pancreas through the gastro- or duodenohepatic route has also been recommended. Here the incision extends through the lesser omentum between the liver and the lesser curvature of the stomach. This route is only satisfactory when a gastroptosis is present. In the majority of cases it is too high and gives a very limited exposure.

The pancreas can be reached through the transverse mesocolon. The greater omentum with the transverse colon is lifted upward and outward and a bloodless area in the mesocolon just below the midcolic artery is incised. Theoretically this route gives a dependable drainage. There is, however, great danger of injury to the midcolic artery. Possible contamination of the small intestine or pelvis outweighs any advantages this exposure may offer.

A bloodless separation of the great omentum and gastrocolic ligament from the transverse colon exposes the lesser omental cavity. It is difficult to coapt the omentum to the thin wall of the colon after the operation is completed, so there is danger of ptosis of the transverse colon. Drainage through this route is not satisfactory. An additional incision through the greater omentum is required for the insertion of the drainage tube.

A great deal of inflammation and necrosis of the omentum are present in pancreatic diseases, hence, separation of the omentum from the colon is not a safe procedure.

Exposure of the pancreas through the gastrocolic route meets all anatomical and surgical requirements.

Technique: A transverse incision is made through the greater omentum and gastrocolic ligament, about half an inch below the gastro-epiploic vessels. The horizontal vascular branches to the omentum from the epiploic arteries and veins are carefully ligated separately with the omental tissue, above and below, but never *en masse*. This step of the technique is similar to the method used for gastrectomy, except that the epiploic vessels are carefully preserved.

The transverse incision through the omentum can be made sufficiently long to give a good exposure. After the stomach is freed it is everted upward with a wide wire or ribbon retractor and the transverse colon is retracted downward. This exposes the posterior peritoneum covering the anterior surface of the pancreas which can be outlined through this structure. A transverse incision over the posterior peritoneum exposes the pancreas. The length of the incision will depend on individual requirements. Closure is obtained by means of interrupted catgut sutures, and the openings made through the omentum and gastrocolic ligament are similarly treated. Drainage tubes or packing can be brought out between sutures.

This exposure may be used as a first stage to marsupialization of a pancreatic cyst.

A small vertical incision through a bloodless area in the gastrocolic omentum has been suggested. This can only be used in emergencies for drainage of a localized abscess. Its usefulness is limited because of poor exposure.

There is no advantage in exposing the pancreas by the transpleural or any other thoracic route.

CONCLUSIONS

1. For thorough examination and surgical intervention of the pancreas the gastrocolic route meets anatomic and surgical requirements. It can also be used as the first stage of a marsupialization operation for a pancreatic cyst or tumor.

2. Mobilization of the second portion of the duodenum gives a valuable exposure of the lower end of the common bile duct and the posterior part of the head of the pancreas.

3. The extraperitoneal exposure is satisfactory where a preoperative diagnosis of a localized pancreatic abscess can be established.

FURTHER OBSERVATIONS ON THE VALUE OF RADIOLOGY IN THE DIAGNOSIS OF PERFORATED PEPTIC ULCER*

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IN November of 1921 we resorted for the first time to the *x*-ray to aid us in the diagnosis of perforated peptic ulcer. Since that time we have had occasion to utilize the fluoroscope in similar cases repeatedly and from time to time to report our results and conclusions. At the annual meeting of the Missouri Valley Medical Association in 1922, one of us (R. T. V.) read a paper entitled "The Value of Radiology in Acute Surgical Abdomen." At this time several *x*-ray films demonstrating spontaneous pneumoperitoneum following perforated peptic ulcer were shown. In 1924 Vaughan and Brams published data on 15 cases of anatomically proved perforated ulcer, in 13 (86.7 per cent) of which free air was present. In the following year (1925) the same authors, in a second publication, added 14 more observations, raising the total to 29. Of this number of proved perforations 86.2 per cent showed evidence of a spontaneous pneumoperitoneum. In a report which included the cases observed up until 1929, we[21] recorded 63 established instances of perforated peptic ulcer which were examined roentgenologically. In 54 (85.7 per cent) of the 63 cases, free air was demonstrated.

In our last publication on the subject we reviewed the literature prior to 1929 but were unable to find any other article dealing with a statistical study of the relative frequency of pneumoperitoneum occasioned by perforated ulcer. Only a few isolated cases were recorded. During that year, however, a report appeared by Kudlek on *x*-ray observations in 24 cases diagnosed as ruptured ulcer. A gas bubble was found in 20, or 83.3 per cent of the patients examined. In 2 of the 4 cases in which free air was absent the diagnosis of the perforation was based on other clinical data. If only the definitely established cases of perforation are included, the percentage of cases with demonstrable pneumoperitoneum increases to 90.9. Inasmuch as the only available statistics are our own and those of Kudlek the present view with regard to the incidence of pneumoperitoneum in perforated peptic ulcer must be based on those figures. Since the percentages of positive cases in the two groups are between 80 and 90, an incidence of approximately 85 per cent is to be looked upon as the current standard.

Recently we have studied from the roentgen standpoint an additional series of cases of perforated ulcer. The results of this investigation indicate that our previously published figures require some modification. During the years 1929, 1930 and 1931 we examined radiologically 97 patients in whom the final diagnosis, clinical or otherwise, was perforated peptic ulcer. In 67 free air in the abdominal cavity was demonstrated. Of this group with *x*-ray evidence of a pneumoperitoneum the diagnosis was confirmed by either operation or post mortem in 53. In the remaining 14 operative intervention was omitted for one reason or another but nevertheless spontaneous recovery ensued. The diagnosis in these patients was based upon the clinical history, the physical examination and the subsequent demonstration with the aid of a barium meal of an ulcer niche or deformity. In the group of 30 patients in whom free intraperitoneal air was not visualized the diagnosis of perforated ulcer was corroborated in 22 by either operation or autopsy. In the remaining 8 the diagnosis could not be indisputably established since neither surgical explora-

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tion nor post-mortem examination was employed. It is thus seen that in our recent group of 97 patients the percentage with

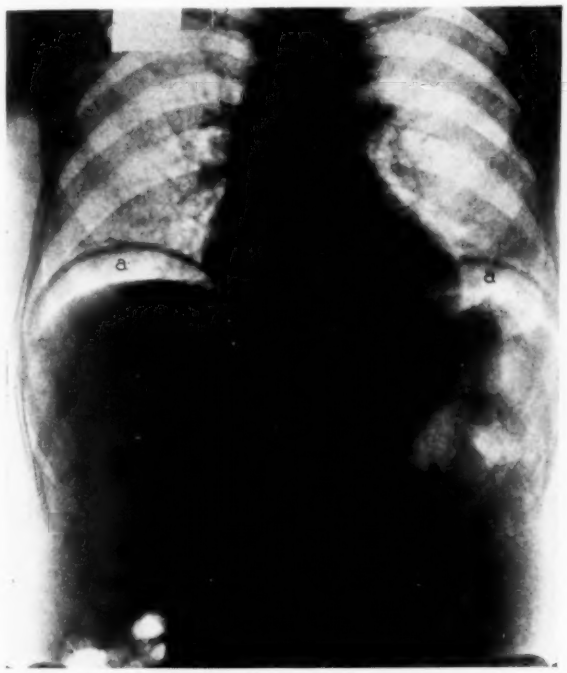

Fig. 1. Pneumoperitoneum due to perforated peptic ulcer. With patient upright, air (*a*) collects beneath domes of diaphragm. Right diaphragmatic leaf is thickened on account of deposit of exudate.

free air was only 69. If one excludes because of the lack of a proved diagnosis the 8 cases without air in which no operation or autopsy was performed, then the percentage with positive observation rises to 75.

The average figure for the last three years (69–75 per cent) although lower than our previous one for the years 1921 to 1929, is still considerably higher than that reported by our Cook County Hospital roentgenologist, Dr. C. H. Warfield. He found in the cases he examined during the year of 1929 that in only 43.5 per cent was a gas bubble demonstrable. There are a number of reasons for the discrepancy between our figures and those reported by Warfield. The chief cause for the difference is that Warfield's figures are compiled for 1929 only, a year in which the incidence for some unknown reason fell far below that of 1930 and 1931, as did ours too. Another reason for the discrepancy is that Warfield did not include, in the positive group, those cases in which air was present but surgical or post-mortem confirmation

Fig. 2. With patient lying on his left side, intraperitoneal air (*a*) is seen to collect between right lateral abdominal wall and right lateral aspect of liver. Same case as Figure 1.

of the diagnosis was lacking. In our report of 1929 we offered evidence to show that in a patient with an antecedent ulcer history the sudden appearance of a diffuse peritonitis associated with a pneumoperitoneum establishes for practical purposes the diagnosis of a ruptured ulcer. The cases with free air which were excluded from Warfield's positive group on account of the want of operative or autopsy confirmation were from the clinical standpoint quite typical. We, therefore, feel justified in including them as genuine cases of ruptured ulcer.

The decrease in the incidence of pneumoperitoneum in our recent cases as compared with the earlier series is due probably to more than one factor. In the first place not all cases suspected of perforated ulcer have been subject to roentgen examination in either period. In the earlier years, when the procedure was relatively new, many classical cases with almost unmistakable clinical pictures were fluoroscoped because of the novelty of witnessing free air. The obscure cases or those in which pneumoperitoneum was not suspected were often operated upon without preliminary *x*-ray

examination. In the past three years, however, in many of those cases with clear-cut perforations roentgen confirmation was prevented. If air fails to find its way to the site of perforation at the time of rupture a pneumoperitoneum will generally be absent.

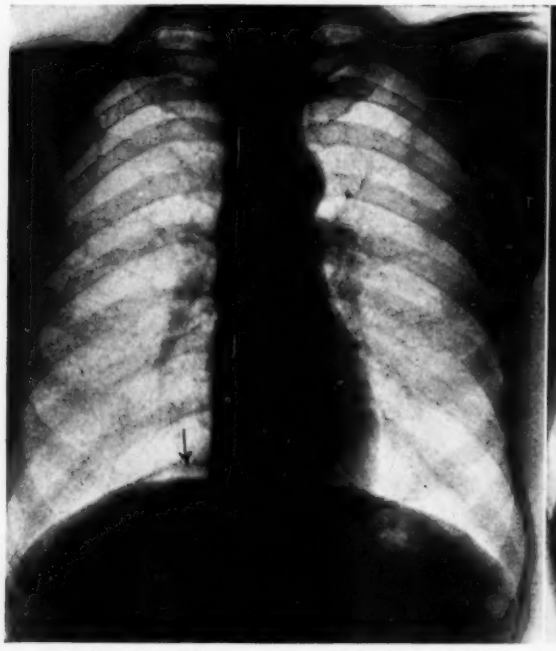

FIG. 3. Sickle-shaped area of radiolucence indicated by arrow is due to free air accumulated between right dome of diaphragm and superior surface of liver. Beneath left diaphragmatic leaf gas bubble of stomach is seen. Clinical diagnosis was *forme fruste* perforation which occurred three days prior to admission to hospital. Operation was not performed.

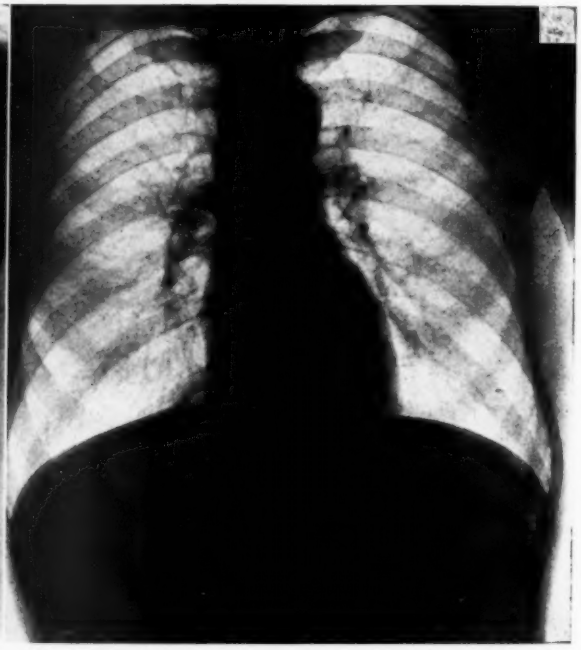

FIG. 4. Roentgen appearance four days after film of Figure 3 was taken. Air has been completely absorbed. Spontaneous recovery from perforation occurred during this time.

omitted, whereas in the questionable or doubtful cases the fluoroscope was generally employed. An equally if not more important factor than the difference in material selected for *x*-ray examination is the recognition of a class of perforations that were previously overlooked. These cases are ones with a small amount of leakage and which, when seen after a lapse of time following perforation, present the picture of perforative peritonitis of short duration and limited extent. On this account we[16] designated these cases as *forme fruste* to distinguish them from the classical type. The explanation of the atypical clinical picture lies in the fact that shortly following perforation, the hole becomes plugged, sealed or covered. Thus further escape of gastroduodenal content is

In a number of *forme fruste* perforations where the clinical diagnosis was at first obscure and free air was lacking we have succeeded in establishing the presence of a ruptured air-containing viscus by a simple maneuver. After the initial negative fluoroscopic examination the patient is placed upon his left side in bed and is ordered to remain in that position. The reason for employing the left lateral position is to render the pyloric region where 90 to 95 per cent of perforations occur the highest point of the stomach. Under these circumstances air if present in the stomach rises to the pyloroduodenal area while fluid and solid material gravitates to the cardia and fundus. If the perforation is still patent or, if previously sealed, reopens, air, if present, will escape into the abdominal cavity. This air can be detected in a fluoroscopic examination made after an

interval of one to several hours following the first observation. We employ this maneuver only in those cases in which the clinical evidence of a perforative peritonitis is relatively slight due to the minimal amount of leakage of fluid. The demonstration of a "delayed" pneumoperitoneum practically establishes the presence of a persistent perforation and indicates immediate surgery which otherwise might have been omitted to the detriment of the patient.

Although the *x*-ray is of great value in the diagnosis of perforated peptic ulcer and can be employed with ease and facility it has been utilized with surprising infrequency. In an article on the use of the *x*-ray in the recognition of ruptured ulcer which appeared in 1929, we[21] included a summary of the cases published from other institutions than the Cook County Hospital. The total was comparatively small because only 33 cases of pneumoperitoneum from peptic ulcer reported by 16 authors were collected. We have since encountered three other articles on the subject (Meyer-Betz, Popovic and Bager) published prior to 1929 which we had overlooked. During and subsequent to 1929 relatively few additional writers have dealt with the subject of pneumoperitoneum in its relationship to perforated peptic ulcer. These include in the approximate chronological order of publication Jaguttis, Soupault, Vernengo, Geier, Kudlek, Schnitzler, Sonnenfeld, Pendergrass and Kirk, Gregoire, Jenkinson and Ellis, Buckstein, Laurell, Asti, Finochietto and Knutsson. Of these the only author who has observed a series of cases is Kudlek.

A number of phases of the subject which have been discussed somewhat at length in a previous publication may well be epitomized here. From the standpoint of diagnosis the *x*-ray is often of paramount importance. In questionable cases, particularly in the *forme fruste* type, it is frequently the only definite means of establishing the correct diagnosis. Visualization of free air indicates without question the presence of a ruptured hollow viscus. The absence of a pneumoperitoneum by no means rules out a perforated ulcer or even militates against the diagnosis. However, it should lead to a more careful search for an explanation of the symptoms other than perforated ulcer. Although occasionally free air in the abdomen occurs with other lesions, for practical purposes a pneumoperitoneum in a patient with antecedent gastric disturbances and signs of a diffuse peritonitis indicates the presence of a ruptured ulcer.

The technique of examination is very simple. The patient is placed on his left side on a cart which is wheeled behind a fluoroscopic screen. It is not necessary to observe the patient in the upright position. Nor are plates essential. If operation is decided upon the patient is wheeled on the same cart from the fluoroscopic to the operating room. The whole procedure requires but a few minutes and entails no risk or discomfort to the patient who while on his left side occupies the most favorable position possible as regards further leakage. Since practically every modern hospital is equipped with an *x*-ray outfit this method of examination lends itself to general use.

Objections that have been advanced to radiologic examination of patients suspected of having perforated ulcer are without justifiable basis. They indicate according to our observations, a lack of experience with and knowledge of this method of examination. We have repeatedly observed that those who have witnessed the use of or employed the *x*-ray in the diagnosis of perforated ulcer find it of great aid. The clinicians and roentgenologists who have written on the subject are uniformly of the opinion that radiology is of distinct value. We, therefore, urge other members of the profession to avail themselves of this notable adjunct in the recognition of ruptured peptic ulcer.

SUMMARY

Previously published statistics indicate that spontaneous pneumoperitoneum can be detected radiologically in approximately 85 per cent of patients with perforated peptic ulcer. In a series of 97 cases diagnosed ruptured ulcer which were observed during the years of 1929, 1930 and 1931 free air was found in 70 to 75 per cent of the patients examined.

The decrease in the incidence of pneumoperitoneum in our most recent as compared with previous series is due in a large measure to increased recognition of a type of perforation formerly overlooked. Reference is made to what we have denominated *forme fruste* perforations, in which almost immediately or shortly after rupture occurs the hole becomes spontaneously closed. As a result only a minimal amount of fluid escapes frequently unaccompanied by air. The mildness of the post-perforative symptoms often leads to an error in diagnosis.

The roentgen examination entails no undue loss of time or handling of the patient. Fluoroscopic observation is all that is required and by this means the presence or absence of air can be determined at a glance. The examination is made with the patient on a cart lying in the optimum position which is on his left side. It is unnecessary to place the patient in a sitting or other position. Those who have employed the *x*-ray as an aid in the diagnosis of perforated peptic ulcer find it of distinct value.

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APPENDICITIS IN CHILDREN*

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AT first thought it may appear that the subject Appendicitis, whether in adults or children, is out of date, that there can be little to discuss regarding a disease whose existence has been recognized for half a century and whose proper treatment has been thoroughly established for many years. But when it can be shown that the death rate from the disease, instead of having lessened until it is slight, has on the contrary actually increased during the past decade it must be admitted that the subject should be very much alive even though many of its victims are not.

The mortality of appendicitis is appallingly high and it reaches its maximum in childhood. I believe it is no longer necessary to speak of a medical treatment for acute appendicitis but that the profession as a whole agrees that acute appendicitis is a surgical disease. The most important factors in producing mortality are delayed operation and administration of cathartics. Both of these are most often met with in appendicitis in children, the former because of the great difficulty of diagnosing the disease in early childhood and the latter because misguided mothers still dose their helpless children with castor oil and other cathartics to a deplorable extent.

Today in all branches of medicine the slogan is prevention and it is through the efforts of preventive medicine that a lowering of the death rate and an increase in the health of the community is sought. My strong belief is that a better understanding of the role the appendix may play in childhood as well as in later life will aid materially in this prompts me to this discussion.

You are all well aware of the seriousness of the acute form in children, that the tendency to early perforation and widespread peritonitis is greater than in the adult; that the resistance to infection is lower, and, to make matters worse, the positive diagnosis of the disease is often far more difficult. The younger the child the more serious the disease and likewise the greater the difficulty of diagnosis.

I am firmly convinced that the occurrence of acute appendicitis in infancy is much more frequent than we have realized, the difficulty and, in some cases, the impossibility of making a positive diagnosis having misled us. The finding of an acutely inflamed appendix in patients subjected to operation upon merely a strong suspicion, when the risk of operation seemed less than that of watchful waiting and the indisputable evidence of previous attacks of acute inflammation found in appendices removed from children never known to have had the disease before, has steadily strengthened this conviction. Each year, study at the operating table, in the pathological laboratory, and of the preoperative and postoperative histories of my patients, has made me realize more fully that both acute and chronic appendicitis is far more common in children than it is usually thought to be; that many cases of acute and subacute appendicitis pass unrecognized and that a large number of children have suffered and are suffering from unrecognized chronic appendicitis.

In early infancy the anatomy and character of the food, as well as many other factors, tend to lessen the likelihood of appendicitis and, undoubtedly, its frequency increases with age.

It is a fact, however, that reports of its occurrence in early life are much more frequent than they used to be and this is,

* Read at the Annual Meeting of the Ontario Medical Association, May 28, 1931, at Niagara Falls, Ont.

I believe, due to more accurate diagnosis rather than to the disease itself being more common.

Appendicitis in childhood, though presenting the same pathology, often manifests itself in a manner quite different from that observed in the adult. The most striking characteristic of acute appendicitis in children is the much greater rapidity with which the disease may progress. The larger amount of lymphoid tissue, the thinness of the appendix wall, and the imperfectly developed omentum of the child undoubtedly are factors. Perforation of the appendix or gangrene during the first twenty-four hours of symptoms is not rare and by the temporary relief of distress following the perforation, has been the cause of many deaths, especially when the appendix was located in the pelvis.

Simple catarrhal appendicitis is, of course, frequently seen, with the nausea, epigastric pain, slight tenderness and resistance in the right lower quadrant, moderate fever and leucocytosis. This picture and the clinical findings are practically the same as those seen in the adult.

Suppurative appendicitis may also give the same symptoms as in the adult. In other cases, however, the diagnosis may be exceedingly difficult and persistent nausea and vomiting may be practically the only symptoms. By this, I mean vomiting of everything taken, even water. I especially want to stress the point that, although pain is in the vast majority of cases the first symptom of acute appendicitis in both child and adult, it is not always so, and the statement often made that unless the initial symptom in an acute abdominal illness be pain, appendicitis may be definitely excluded, is misleading and absolutely false. Abdominal pain, muscle spasm, fever and leucocytosis may all be absent and yet the case be one of suppurative appendicitis. Fortunately, such cases are not common, but in any child with such vomiting extending over a period of thirty-six hours the appendix should be suspected if other causes of vomiting have been ruled out.

One of the signs which we have been taught to think most important in diagnosing the disease, namely abdominal muscle spasm or rigidity, is absent in a greater proportion of cases in children than in the adult. Somewhere in the past, teaching has been at fault and too much stress has been laid upon this sign as being necessary in the diagnosis of acute appendicitis, both in adults and children. My impression is that its absence has been the cause of more delayed diagnoses than any other factor. If we will pause for a moment to consider the cause of muscle spasm we will at once see that its presence or absence depends almost entirely upon the location of the appendix. It is the involuntary effort of the muscles to protect an inflamed and sore structure which lies behind them that causes the rigidity. When the inflamed appendix lies in the right lower quadrant in an anterior position, we find the muscles over this quadrant rigid; when it lies retrocecally, we usually find but little rigidity and only a reflex spasm on deep palpation, but we do find rigidity in the flank. When the inflamed appendix lies well within the true pelvis we may and usually do find rigidity of the abdominal muscles absolutely lacking. They have nothing to protect and therefore are not on guard. It is only later when the peritonitis caused by the perforation of the appendix has spread beyond the pelvis that rigidity appears. This pelvic location of the appendix is more common in childhood than in later years.

Rectal examination will often be of aid, but here again too much value must not be placed on negative findings.

Another type more often met with in children than in adults is the acute hypertoxic variety in which the virulence of the infection is most marked and the toxemia out of all proportion to the local abdominal signs. This type is frequently accompanied at the outset by offensive diarrhea, and,

unless early operation is performed, runs a rapidly fatal course.

It is not, however, my purpose today to discuss the various signs and symptoms of the different types of acute appendicitis, nor to discourse upon differential diagnosis. I wish more especially to discuss the so-called chronic form, but I cannot resist this opportunity to urge operation in every acutely sick child when appendicitis can be reasonably suspected and cannot be definitely excluded. The proper use of avertin as a basal anesthetic has so simplified operating upon children by removing all psychic shock and lessening the need of inhalation and increasing the scope of local anesthesia, that I have no hesitancy in taking this stand. I have seen so many late cases in consultation and so many have come to our hospitals when the "wait till morning" or the "wait to be certain" attitude has allowed a simple appendicitis to be converted into a fatal peritonitis, that I am convinced such an attitude will avert many a tragedy. Mistakes will, of course, be made, but how much better to sacrifice many an innocent though suspected appendix than one innocent child who might have been saved by timely operation. Furthermore, by removing even a normal appendix we have at least insured the patient against the disease in later life. Not that I am so radical as to advocate the removal of all appendices in childhood as a prophylactic measure as some advise circumcision in all males, but that every appendix once diseased predisposes to serious trouble in the future I firmly believe and I feel no chagrin when operative findings make it appear as though the patient might have weathered that particular attack without operation. To the surgeon the saddest two words in the language are the words "too late." We must needs use them most often in appendicitis in children and in cancer in adults. That immediate operation should be the absolute rule in every case in which the diagnosis of acute appendicitis is definitely made I believe admits of no argument. More urgent and essential is early operation if a cathartic has been given. While the statement no purgative, no perforation is a slight exaggeration, it is, however, true that perforation of the appendix before walling off has taken place is rare when no purgative has been taken, but very common if one has been. There is no more certain means of hastening perforation and transforming a simple appendicitis into a spreading peritonitis than the administration of a dose of castor oil. It is our solemn duty to teach mothers that to give castor oil to a child with the belly ache is on a par with giving it a rattlesnake to play with.

Chronic appendicitis is a most unfortunate term and its use has caused an endless amount of discussion and waste of words and energy because those discussing have usually been talking at cross purposes, due to the fact that neither has understood what the other has meant by the term. The suffix "itis" of course denotes the presence of an active inflammatory process, and the absence of any such process in the appendix when studied by the pathologist has led to confusion.

In our discussion today I wish to include under this term not merely the occasional cases in which a subacute or chronic inflammation does exist, but the large number of cases in which mechanical irritation either from within the appendix or in its immediate neighborhood is producing ill-health. This mechanical irritation with its consequent varied reflex manifestations may be produced by concretions within the appendix, by acute kinks due to a short or distorted mesoappendix, or by adhesions or congenital peritoneal bands, or by constrictions produced by scars resulting from previous acute inflammation. In such cases the irritation is presumably produced by the effort of the appendix to empty itself in the presence of obstruction of its lumen. In other cases post-inflammatory adhesions of the appendix interfere with the normal mobility of the cecum or with the proper functioning of the

ileocecal valve; in others we find a marked thickening of the walls of the appendix itself. In still other cases a congestion or hypertrophy of the lymphoid tissue in the appendix which is normally more abundant in the child than in the adult seems to be the irritating factor, just as its presence undoubtedly partly explains the greater frequency of acute appendicitis in the first half of life. I have frequently seen this lymphoid hypertrophy so marked that the appendix lumen was nearly obliterated and the organ itself stiff and hard to the touch. In such an appendix a very mild infection may produce most marked initial symptoms of an acute attack and lead to prompt operation. These are the cases in which the operative findings may seem scarcely to explain the clinical picture, until the appendix is sectioned and the swollen, inflamed lymphoid tissue is seen. We might also include the Lane kink and so-called Jackson's veil as occasional offenders and productive of symptoms. However, strange to say, these supposedly congenital abnormalities seem rarely to produce symptoms in childhood. The type so often seen in adults where the premature atrophy and cicatrization of the appendix causes irritation to its nerves and hence reflex phenomena is rarely, if ever, seen in childhood. When we come to discuss the symptoms that might be produced by chronic appendicitis we find that they are many and varied, just as they are in the adult.

That chronic appendicitis in the adult is a well-recognized entity must be admitted even though many cases wrongly so diagnosed and subjected to operation have brought regret to all concerned. The frequency of its occurrence in childhood is, however, not nearly so universally appreciated and it is the firm conviction derived from my own clinical experience that the condition is relatively common in children though often unrecognized that prompts me to discuss it here.

Could we observe all cases of acute appendicitis that occur I believe that we would find that but a small percentage are either fatal or come to operation in the first attack, or even the second or third. I believe it is the rule to have several or many mild attacks before a serious one occurs. I am thoroughly of the opinion that a large percentage of the abdominal complaints of childhood, the belly aches, the mild or moderately severe attacks of so-called enteritis or colitis are in reality attacks of appendicitis; that in others if it be not the primary cause of the complaint, the appendix is involved in the process and to such an extent that it is permanently injured and a potentially harmful organ is produced. I also believe that a large percentage of children who have finicky appetites and are undernourished and suffer from vague digestive disturbances are really suffering from chronic appendicitis, and that many cases of recurrent vomiting of the so-called cyclic type as well as many cases of so-called acidosis are due to this disease. Positive proof of the correctness of this opinion has been furnished by two groups of cases.

One group is that in which an attack of acute appendicitis has brought the child to operation and an appendix has been removed containing concretions or showing other evidence of previous inflammation, and following which operation the child has remained well and free from the old complaints and previous history of indigestion, acidosis, etc. I have a large number of cases in this group in which there is a history of repeated attacks of acidosis, digestive disturbances of intermittent or periodic character, many unaccompanied by pain, some in which indefinite nonlocalized pain has been present, but in none of which appendicitis had been thought possible because of the lack of any well-defined pain in the right lower quadrant.

These cases have shown such marked improvement in health following operation that I have had many a parent say that they considered the acute attack that necessitated it to have been a blessing.

The second group is as yet somewhat smaller, though I am glad to say that the disproportion is steadily decreasing, for the frequency with which the appendix is to blame is not realized.

In this group are the cases in which either the diagnosis of chronic appendicitis has been made or operation has finally been resorted to after all other means have been tried.

I am not going to quote statistics nor case reports but will cite a case in each group, not as being unique or of special interest except as being typical of its group and for the fact that each had been for several years under the observation of pediatrists of the highest standing and ability without the real cause of their ill health having been recognized. There is a surprisingly large number of little neurasthenics between the ages of five and twelve, the basis of whose trouble lies in a chronic appendicitis. Of this I have had ample proof, for following the removal of the appendix the nervous manifestations have disappeared, the appetite improved, the child has gained in weight and become perfectly healthy and normal.

First, as typical of group one, namely the group in which an acute attack has caused the removal of the appendix with subsequent relief of ailments for which the appendix had never been blamed:

A child aged six was seen about eighteen hours after the onset of an attack similar to a number of others suffered at intervals during the previous two or three years except for the complaint of slight abdominal pain in this attack. In the previous attacks no pain had been complained of; there was nausea and vomiting, and the child was apathetic, and the case was considered to be acidosis. In this attack the temperature was *normal* but the complaint of abdominal pain, the presence of slight tenderness in the right lower quadrant, a leucocyte count of 14,000 with 95 per cent polymorphonuclears, made the diagnosis of acute, possibly gangrenous, appendicitis probable. Immediate operation was performed and a distended, tense, acutely inflamed appendix was removed. When the appendix was later incised it was found to be filled with pus, its entire mucosa gangrenous, and to contain a hard, round concentration ¼ inch in diameter which must have taken years in the making. In the subsequent four years there has not been a single attack of so-called acidosis.

As typical of group two, namely the group in which operation was made because all other attempts at relief of symptoms had failed and a diagnosis of chronic appendicitis had been finally made by exclusion:

A child, eight years old, had cyclic vomiting, so-called acidosis at intervals of six to eight weeks, had been under the observation of many physicians and pediatrists, had worn a belt for gastrocoloptosis and had become almost a neurasthenic. As the *x*-ray showed a retrocecal appendix retaining bismuth for seventy-two hours, chronic appendicitis was considered. There was no tenderness in the region of the appendix or anywhere in the abdomen except at Morris' point.

At operation a long appendix was found lying behind the cecum and running toward the median line and intimately adherent to the mesentery of the terminal ileum. The location of the adhesions could readily explain a pull that would cause reflex pylorospasm. Following operation the child was entirely relieved of his complaints. He gained in weight, steadily improved in health, and three years later was reported as being a perfectly well, normal child.

Just a word or two regarding the diagnosis of chronic appendicitis, and this applies both to children and adults.

An appendix that is causing reflex disturbance, pylorospasm, epigastric distress, or any of the various complaints it may produce, is not necessarily a tender appendix and, in fact, is rarely so. I believe that in chronic appendicitis tenderness over the appendix is the exception rather than the rule. Tenderness at McBurney's point belongs to acute appendicitis, not to chronic. Pressure over the region of the appendix may cause pain or distress in the epigastrium or other location where discomfort has been present, but not in

the location where pressure is exerted. There is, however, a tender point that I have found in a very large percentage of cases and that is at a spot an inch or so to the right of the navel. Deep finger point pressure at this spot will elicit pain when pressure at a corresponding point to the left or over McBurney's point causes no discomfort. This observation was first made by R. T. Morris and is a fairly constant finding.

Another sign is marked tympany of the right half of the abdomen due to relaxation of the walls of the cecum and ascending colon. Both these signs are evidences of prolonged nerve irritation from a nagging appendix manifest in the first instance by a hypersensitive nerve ganglion and in the other by nerve exhaustion.

Neither is pain in the right lower quadrant a necessary accompaniment of the disease. If it is present I believe it is of more significance in the child than in the adult, the psychoneurotic element being less apt to play an important part in a child's complaints. When an adult comes to me complaining of pain wholly confined to the right iliac fossa and it constitutes the only sign, I am at once prejudiced against the diagnosis of appendicitis. Pain in chronic appendicitis is felt not in the lower abdomen but in the epigastrium and though many patients do have pain in the right lower quadrant, such pain unaccompanied by other signs and symptoms is not sufficient evidence to justify operation.

There are just three thoughts I wish to emphasize:

1. We must continue to broadcast the danger of catharsis in the presence of abdominal pain.

2. We are justified in operating upon every case of suspected acute appendicitis in children when we can not exclude its presence, and we should have the moral courage so to do.

3. Chronic appendicitis should be more frequently and seriously thought of as a possible cause of ill health in childhood.

MANAGEMENT OF HEAD INJURIES*

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THE immediate treatment of a head injury should be directed towards the question of shock. Blankets and hot water bottles are advised on admission to the hospital. The head is lowered. The patient is given an ampule of 7½ grains of caffeine-sodio-benzoate, as this drug is a stimulant for shock and has the added advantage in head injuries of reducing intracranial pressure. This drug should be continued every four hours until signs of increased intracranial pressure cease or unless contraindicated by undue restlessness of the patient. Fluids by vein or hypodermoclysis should not be used in treating shock as they predispose to early cerebral edema. Dehydration treatment is postponed until shock is relieved. Compound fractures should be disregarded, except for the application of tincture of iodine and a sterile dressing, until all evidences of shock have subsided. Fifty cubic centimeters of 50 per cent glucose solution are given intravenously as early as possible to treat the shock and later should be used as a part of the dehydration treatment. Morphine is a respiratory depressant. It is very seldom indicated even in shock following the head injury or in the most restless patient. It is best not used in these cases.

It is unwise to attempt the suturing of scalp wounds in a patient in marked shock. Frequently this has been done by someone by the time we see the patient. It is not uncommon to find beneath these wounds a compound or comminuted depressed fracture. It is best to treat the shock, wash out the wound with iodine, and apply a sterile dressing. After the patient has been put to bed and reacts from shock, debridement and closure may be performed. As a rule I do not apply a dressing to scalp wounds after suturing. Dressings annoy the restless patient, are frequently pulled off anyway, and if applied tend only to macerate the wound. A sterile towel placed on the pillow is usually sufficient dressing to a closed scalp wound. Frequently scalp wounds are closed too tightly. A few sutures to control hemorrhage are usually all that is necessary even in a long laceration. Ears discharging blood should never be irrigated. They should be kept sterile by being swabbed out with an antiseptic. A piece of sterile gauze should be carefully placed in the external canal and changed when saturated. Rest in bed for two weeks in the less severe cases with symptoms to a longer time in the more serious cases is a necessary measure in treating these patients. After the patient has reacted from shock the head should be elevated. The use of the ice bag to the head is advisable, especially in treating the patient's relatives and friends.

No matter how trivial a head injury it should be considered serious until proved otherwise. If the roentgenograms are negative for fracture of the skull the patient should be put to bed under close observation. Hourly blood pressure readings are important even with negative roentgenograms because frequently a fracture line may not be revealed. An hourly record should be kept of pulse and respirations. In the more serious cases with fracture and unconsciousness the record of the blood pressure, pulse and respirations should be made at more frequent intervals.

Seldom is it necessary to obtain *x*-ray plates in order to make a diagnosis of a fracture of the skull. During the first day or two of treatment in certain cases in shock and coma it is far better to treat the

* Read before Lycoming Co. (Pa.) Medical Society, November 11, 1932.

patient's cerebral injury than to submit him to the excitement of a ride to the *x*-ray room and a multiplicity of turns, rolls and grotesque positions on the *x*-ray table, when such an ordeal gives us no definite estimate of cerebral trauma. The patient should be kept quiet and free from undue disturbances until reaction from shock has been accomplished. I do not mean to infer that roentgenograms are not of the utmost importance to us in determining the location of the line of fracture and of appraising the extent of depression or comminution of the bone, but early in the case this information is of little value to the surgeon, as these findings do not in any way alter the course of treatment.

In the dehydration therapy, besides the intravenous use of 50 c. c. of 50 per cent glucose solution every eight hours, it is well to give 4 oz. of 50 per cent magnesium sulphate solution slowly per rectum every four to six hours. Fluids are restricted to not over 20 oz. a day in the conscious patient at the start, but later are given more freely. No attempt is made to administer fluids while the patient is unconscious. Magnesium sulphate may be given by mouth if the patient is conscious and it does not disturb him too much. Close observation of the patient's general condition should determine the amount of dehydration necessary as there is danger in carrying this treatment too far. Here, as in other measures, our course is governed by the condition of the individual patient.

When intelligently and carefully performed, lumbar puncture is of vast help in these cases and is useful in conjunction with the dehydration treatment. The finding of bloody fluid should indicate to us the need of a subsequent spinal drainage. Lumbar puncture is a valuable procedure in determining fractures of the base. The head should be lower than the rest of the body when a lumbar puncture is done and should not be elevated after puncture has been performed. Repeated lumbar punctures are advisable in cases showing persisting signs of increased intracranial pressure. Otherwise, a patient seldom needs more than one tapping and in the event the manometric reading is high enough fluid should be drained off to lower the pressure one-half the distance to normal. Often only a few cubic centimeters are necessary to do this. I have seen marked improvement following this procedure and believe it should be repeated as symptoms of increased pressure return. One should, however, in all cases be guided entirely by the condition of the patient.

Eye-ground examination revealing evidence of a papilledema is a definite indication of the need for lumbar puncture, and if there be muscle twitching or paralysis with a fixed dilated pupil, the evidence points to extradural or subdural hemorrhage amenable only to operation. A dilated pupil per se signifies pressure on the same side but is not of itself an indication for operation.

Not only should we combat shock and wait sufficiently long for the patient to react from it but delay in operation is often wise. This should mean waiting for two to five days if possible. This cannot be done in cases of rapidly increasing extradural hemorrhage but is entirely possible in depressed fractures.

In 4 cases of depressed comminuted fractures which have come to operation in our hands in the last three years the average interval between accident and operation was three and one-half days. Another case of subdural hematoma was operated on eight days after the accident. A sixth case of extensive injury to the brain with a compound comminuted fracture was operated on within a few hours after the accident and as soon as he reacted from shock. This patient was having free drainage of cerebrospinal fluid from the wound with a large amount of brain hanging out of the wound over his face. In a case of extensive maceration of the brain in a little girl who suffered a severe comminuted fracture operation was performed five days following the injury. Fortunately there are no

deaths to report in this series of operations.

In 26 fractures of the skull, all proved by *x*-ray, which have been under my care in the past three years there have been 3 deaths. One man who had a fracture of the vault died of pulmonary embolism from the site of amputation of a leg, the day following his injury. The fracture of the skull was a linear one and there was no marked intracranial pathology. These facts were confirmed by autopsy. The second patient who had a fracture of the vault also had multiple fractures of the pelvis, and compound comminuted fractures of both bones of both legs. He was seventy years of age, the oldest in our series, and died eight days after the accident of renal complications. The third death is the only one in this series of 26 cases in which death occurred from the cranial injury. This man had a fracture of the base in the middle and posterior fossae and also the vault, and expired within twenty-four hours without any localizing symptoms or signs. His systolic blood pressure never registered over 144. A spinal tap revealed pure blood under 22 mm. of pressure. About 4 c.c. of this fluid were obtained and death ensued shortly afterward, apparently from a medullary edema with respiratory failure. The mortality rate in 26 cases with 3 deaths is 11.5 per cent.

The following are indications for surgical interference:

1. Depressed fractures
2. Subdural or extradural hemorrhage
3. Compound comminuted fractures with cerebral injury. In this latter group is included the removal of accessible foreign bodies.

In all cases of head injury, except in the three classes just enumerated, the fracture should be disregarded entirely. The problem is one of intracranial injury and not of fractured skull. We must determine the presence or absence of intracranial trauma and treat the patient for the underlying pathology in the contents of the skull. This may be hemorrhage, laceration, pressure atrophy, anemia or edema of the brain. We subscribe to the principle of conservative treatment consisting of rest in bed, dehydration, and lumbar puncture, with operative interference as a last resort only in the cases which do not respond to this treatment and which fall in the category of the cases suitable for operation as already mentioned.

VARICOSE ULCER OF THE LEG

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CIRCLEVILLE, O.

IN 1876, at the Demilt Dispensary in New York City, I had to dress numerous cases of varicose ulcer of the leg every day for many months. The disease occurred for the most part in middle-aged and elderly women and the ulcer was often large, deep and very painful. The plan in use at the time was to scrub the leg and ulcer with soap and water, pack the ulcer with lint saturated with balsam of Peru and over this stretch diagonally strips, about ½ inch wide, of moleskin plaster reaching two-thirds around the leg. This treatment did much good, but I do not recall any case that was cured.

In 1878 my attention was directed to a method of treatment of varicose ulcer of the leg devised and practiced in my home town by Dr. S. D. Turney with uniform success. About this date he published an account of his treatment in the *Obio Medical Journal*, and, since then, I have contributed several times articles to different medical journals on his plan, which I have from time to time slightly modified. As the method is so successful I have always felt that it should have greater publicity than it has received.

Hundreds of cases of varicose ulcer of the leg have been treated by me, in more than fifty years of active practice, with practically no failures and no return of the ulcers if instructions were followed. The plan is as follows:

In very severe and painful cases with swelling of the legs (often there is one or more ulcers on each leg) the patient is put to bed for a week or two, seldom more than a week. The majority of patients, however, are ambulatory without much swelling, and can be treated without interfering with their regular work.

Whether an ambulatory case or not the diseased limb is first washed with soap and water, well lathered with suds, and, after being rinsed with clean water, dried. The ulcer is then swabbed with 1:1000 solution of bichloride of mercury, applied thoroughly but gently. If the ulcer is deep and the edges undercut, a piece of fine mesh gauze, cut to fit over the ulcer within the area of the destroyed skin, dampened with the bichloride solution is applied. Over this is laid a pad of several thicknesses of gauze held in place by a few narrow strips of zinc oxide plaster. This is done at bedtime. Immediately following this the limb is tightly wrapped from toes to the knee with a 2½ inch para rubber Esmarch bandage. This should be tight enough to drive all the blood from the vessels and should remain on from five to ten minutes, but not long enough to produce discomfort. When the time is up this bandage is suddenly loosened above and rapidly unwound. By this means the stagnant blood in the veins is driven out and its place supplied by an onrush of fresh blood which furnishes stimulation to the starving cells of the ulcer. The bichloride dressing is left on until morning, when the process is repeated. If the limb is edematous the patient is kept in bed and the process described repeated night and morning until the swelling has subsided sufficiently for measuring for a light weight or medium weight elastic stocking. This stocking must be made to order to fit the leg. Trade stockings seldom answer the purpose because they do not make even pressure, and one that does not fit will be worse than useless. There must be equal elastic pressure on every part of the leg; especially, it should never be tighter at the top than elsewhere.

As soon as the stocking comes from the factory, generally four or five days, it is put on in the morning after the treatment with the Esmarch bandage, and taken off at night before the treatment and left off until morning. Granulations start in a few days, secretion from the ulcer becomes less and less and soon a white line of new skin begins to show around the edge of the ulcer. At this stage it is best to cover the granulations for a few days with fine gauze spread with zinc oxide ointment.

In cases without swelling the treatment is not begun until the elastic stocking arrives, then the same course is pursued as described except that the patient is not confined to bed. The length of time for the healing of the ulcer of course depends somewhat on the general condition of the patient and the amount of skin involved. Often a Wassermann reaction of three or four plus is found; in this event appropriate specific treatment is given. In days before tests for syphilis were in use there were no failures in healing the ulcer although some must have been syphilitic in character. After the ulcer is healed, which is accomplished in a few weeks' time, according to its severity, the patient must continue to wear a properly fitted elastic stocking. With this treatment the veins seem to become smaller, and after several years the elastic stocking may be dispensed with for months at a time. The injection method of curing varicose veins of the leg can, after the ulcer is healed, be used in selected cases to great advantage. The treatment described is so uniformly successful, so simple, cleanly and comfortable in its results, that I know of no other procedure that compares with it for satisfaction to patient and physician.

The applications to the ulcer can be varied to suit the case or the convenience of the physician. Undoubtedly it is best at first to use some strong germicidal solution to the ulcer, it should not be forgotten that air and dryness are essential to rapid healing, consequently, the sooner all ointments and irritating antiseptics can be dispensed with the better.

USE OF SODIUM MORRHUATE IN INJECTION TREATMENT OF VARICOSE VEINS*

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THE conflicting reports appearing in the recent literature concerning the use of sodium morrhuate in the treatment of varicose veins by injection, and the results obtained, prompt me to report my experience with this agent in the treatment of more than 600 patients with approximately 4000 injections.

Levi[1] in comparing the relative value of various solutions for sclerosis of varicose veins concluded that sodium morrhuate was much less irritating than the more commonly used solutions such as quinine hydrochloride and urethane, and sodium salicylate, and did not cause sloughing if injected into the subcutaneous tissues. The reaction it produced in the vein was much less severe; the injection almost painless and the discomfort afterwards not great. Most of the patients reacted to the first injection. There was not the same tendency to extensive clot formations as with quinine and urethane. No general toxic symptoms occurred.

Smith[2] in a like study, comparing the various sclerosing agents used in this work at the Mayo Clinic, found that sodium morrhuate had a sclerosing action equal to the more commonly used agents and gave no pain or systemic reaction. In a strength of 3 per cent, it was the ideal sclerosing solution for stellate or spider-burst veins. For the usual case a 5 per cent solution was used. Smarting may attend the injection but one can be sure that sloughing will not result. In more than 2000 injections he had not experienced a slough and the incidence of recurrence was less with this and with quinine and urethane, than with any other solution he had used.

Kilbourne, Dodson and Zeiler[3] in their experimental work on animals to determine the toxicity, slough producing properties and bactericidal action of the common agents used for the injection treatment of varicose veins concluded that sodium morrhuate was non-toxic and that when it was injected outside the vein the sloughs it made were not as serious as the quinine and salicylate sloughs; it was not bactericidal or self-sterilizing.

Tunick and Nach[4] reported on the use of sodium morrhuate in a series of 600 injections in 200 cases in which they had obtained results identical with those reported by Levi, Smith and others.

Higgins and Kittel[5] record the interesting observation that sodium morrhuate in 5 per cent strength was apparently more effective when injected into a distended vein with the patient standing. Sodium morrhuate in 5 per cent strength was used in a series of 187 cases. They reported no sloughs, 14 cases of periphlebitis and no evidence of recurrence in the cases seen after an interval of six months.

During the past year I have used sodium morrhuate in 5 per cent strength in a series of more than 600 patients with approximately 4000 injections.

In all cases a complete history was obtained with particular reference to the previous occurrence of milk-leg, thrombophlebitis and swelling of any sort. The customary tests to determine the patency of the deep venous circulation were performed in all cases.

TECHNIQUE OF INJECTION

The skin at the site of injection is prepared with tincture of iodine followed by alcohol.

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Those cases presenting very large varices are treated according to the method of McPheeters, namely, isolation of a segment of the vein between tourniquets after the vein is emptied by elevation of the limb, the patient being in a recumbent position.

The vast majority of patients, however, are treated while standing or sitting on a high table or platform with the legs in a dependent position, which posture renders the veins more prominent. A 5 c.c. Luer syringe fitted with a sharp, short bevel, 25 gauge needle is then very gently and firmly pushed through the skin into the vein with the needle pointed upward. The position of the needle in the vein is quickly ascertained by the presence of blood which trickles through the needle into the syringe. If the vein is small the injection is given without further preparation; if medium-sized or large, the vein is milked with the thumb and middle finger of the left hand, or by an assistant, after which the injection is given.

I usually inject from 0.5 to 3 c.c. of the solution at any one site and as a rule place the first injection at the highest point in any vein or group of veins.

As soon as the desired quantity of solution is injected, a tonsil sponge moistened with alcohol is placed firmly over the site of puncture and the needle is withdrawn. An adhesive strap about 7 in. long and 1 inch wide is then placed over the sponge, binding it firmly over the injected area. The patient is instructed to remove the dressing after forty-eight hours and not to massage or rub the limb at the point injected.

Injections may be repeated every second day and in no case is a total quantity of more than 5 c.c. of the solution injected at one sitting.

All patients presenting extensive varicose vein formations are instructed in the proper application of a spiral elastic bandage which they are requested to wear throughout the treatment and for about one month after its completion.

RESULTS

The only untoward reaction noted in my early use of sodium morrhuate in 5 per cent strength was the occasional occurrence of a mild to moderate dermatitis with annoying pruritus. This is a transitory reaction and can be ameliorated with the usual antipruritic lotions. At first it was thought to be an allergic phenomenon, but a careful check on our cases revealed the fact that most of the patients presenting this complication had been treated with larger quantities, 10 c.c. of the solution. This reaction, therefore, may be considered a quantitative reaction as well. Since limiting the quantity of solution injected at one visit to 5 c.c. I have rarely seen this complication occur.

Occasionally also, I have observed cases in which one injection of sodium morrhuate in 5 per cent strength is followed by a rather widespread reaction in and around the vein, characterized by infiltration, thickening, tenderness and reddish discoloration. This reaction may extend for a distance as great as 18 or 20 in. along the course of the vein, suggesting a rather widespread phlebitis and periphlebitis. To one unfamiliar with these cases, this phenomenon may cause some alarm, but careful inquiry will reveal the fact that the patient has had no chills or febrile reaction and in a few days the swelling and tenderness begin to subside. In my opinion this reaction merely presages an excellent and thorough obliteration of the vein.

Not one case of injection ulcer or sloughing has occurred in this series of cases.

For several years prior to the general employment of sodium morrhuate in the injection treatment of varicose veins, I had used sodium salicylate in various concentrations, quinine hydrochloride and urethane, and 50 per cent dextrose mixed with equal parts of 30 per cent saline solution, in a series of more than 15,000 injections. A comparison of the results obtained with these solutions and with 5 per cent sodium morrhuate leads me to conclude that sodium morrhuate is more

effective, safer and attended with fewer dangers and complications than the other agents used in the sclerosing treatment of varicose veins.

SUMMARY

Sodium morrhuate in 5 per cent strength will not cause toxic symptoms when used in the proper quantity.

Sodium morrhuate will not produce an ulcer or slough if injected into the perivenous or subcutaneous tissues.

Sodium morrhuate will not produce an infectious phlebitis if a proper, aseptic technique is observed.

The objectionable symptoms (pain, cramp and systemic reactions) and sequelae (sloughs, residual discoloration and nodulation) resulting from the injection of the other solutions will not occur with the use of sodium morrhuate.

Five per cent sodium morrhuate meets with all the requirements for a safe and effective sclerosing agent in the injection treatment of varicose veins.

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OBSERVATIONS FOLLOWING SYMPATHETIC GANGLIONECTOMY IN CASES OF POST-ENCEPHALITIC PARKINSONIAN SYNDROME

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THE question of the value of surgical procedures upon the sympathetic nervous system in cases of disturbed motor function has aroused a great deal of controversy. Investigators in this field are not in accord as to the influence of the vegetative nervous system on voluntary muscle. Wilkinson[1] believes that there are no sympathetic fibers to voluntary muscle other than those of vasomotor control. Boeke[2] has demonstrated what he believes to be sympathetic nerve endings in the muscle cells. Hunter,[3] Kuntz[4,5] and Fulton[6] have observed that sympathetic impulses influence the resting tone and that they are factors in the stretch reflex. Charlet[7] and Maibach[8] have well demonstrated that the sympathetic nervous system has an influence on fatigue in that sympathetic stimulation increases the amplitude of contraction of fatigued muscle in response to motor impulses. This experimental work has been carried out on animals under normal conditions and under artificially produced pathological conditions such as section of the motor tracts, decerebration, etc. and is apparently only a beginning for further study necessary to clarify the problem from a physiological standpoint. Results of operations upon the sympathetic nervous system in patients with pathological changes affecting neuromuscular control have likewise brought forth great differences of opinion as to the merits or demerits of this procedure. In cases of spastic paralysis Royle[9,10,11] and Stewart[12] report good results; a group of men[13] in England reporting on 6 cases of spastic paralysis operated upon by Royle while in England believe the procedure to be of no value; and Carrell[14] reports varying results and recommends careful selection of cases. The variations in type of operation and type of case may be influencing factors in these conclusions. The important clinical outcome of this work is that in some cases of spastic paralysis the spasticity has been greatly lessened and there has been a remarkable return of function following the complete interruption of sympathetic tracts to the affected extremities.

The reported results of this operation in cases of post-encephalitic Parkinson's syndrome[9] have not been as good as in cases of spastic paralysis. This may be due to the fact that in post-encephalitic parkinsonism we are dealing with a degenerative process in the basal nuclei, which is progressive and subject to almost continual variation.[15] In 2 of our cases there were definite postoperative changes in the patient's condition which have been maintained. In the third case there was marked improvement. In no case was any attempt made at postoperative re-education of the involved muscles.

In operating upon the cervical ganglia we used the posterior approach following the technique outlined by Adson[16] with the exception that in addition to resection of the first rib and transverse process, we also resected the second rib and transverse process. This modification greatly facilitated the removal of the lower cervical and the first and second dorsal ganglia. We believe that it is necessary to remove the second dorsal ganglion since, as Kuntz[4] has shown (Fig. 1) there is, in a large percentage of cases, an intrathoracic ramus (R 1) which connects the second dorsal nerve (T ii) with the first dorsal (T 1) and a grey ramus (X) from the second sympathetic ganglion which joins this intra-

thoracic ramus thereby giving additional sympathetic nerve supply to the first nerve; there is also not infrequently a grey ramus running directly from the second ganglion to the first spinal nerve. At the first operation in our second case we removed the first dorsal and the lower cervical ganglia. Following this procedure there was activity of the sweat glands in the axilla and on the lower border of the arm to the elbow. Such activity could be due to sympathetic nerve supply through the intercostobrachial nerve (second and third dorsal) but the distribution was lower than would be expected from the usual extension of this nerve; it could also be due to sympathetic nerve supply to the first dorsal spinal nerve from a communicating ramus of the second ganglion, distributed via the medial brachial cutaneous nerve. In those cases in which we removed both the first and second ganglia there was no sweating either in the axilla or of the arm. In the operations for the lower extremities we have used the transabdominal[17] approach and have removed the second, third and fourth lumbar ganglia, thus interrupting all of the sympathetic fibers.

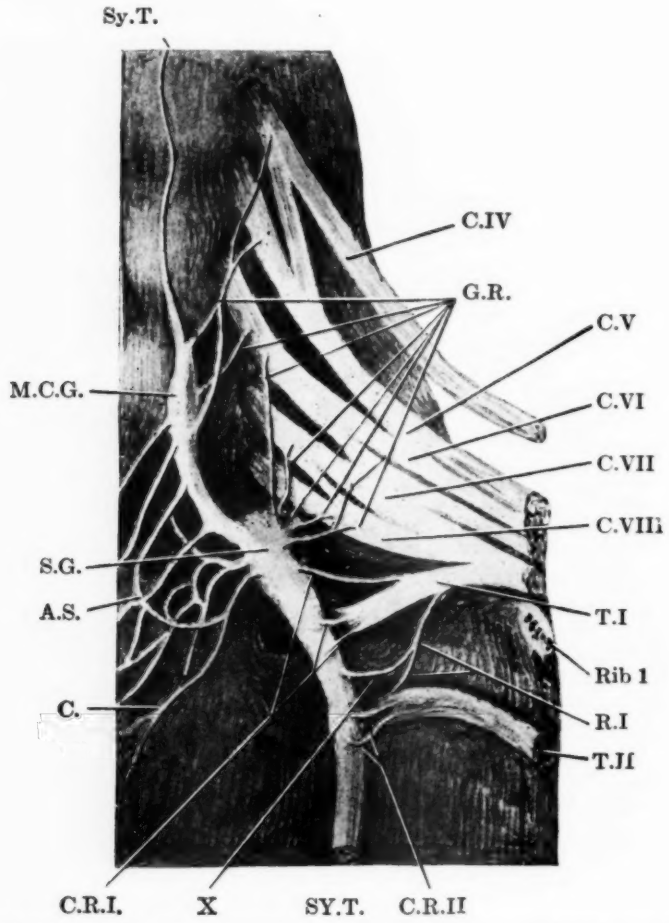

Fig. 1. Drawing from cadaver to illustrate inconstant intrathoracic ramus from second to first thoracic nerve and communicating rami joining brachial plexus. A.S., ansa subclavia; C., cardiac nerves; C.IV to C.VIII, cervical nerves; C.R.I, communicating rami to first thoracic nerve; C.R. II, communicating rami to second thoracic nerve; G.R., grey communicating rami to cervical nerves; M.C.G., middle cervical ganglion; S.G., stellate ganglion; SY.T., sympathetic trunk; X, sympathetic ramus joining ramus from second to first thoracic nerve; T.I, first thoracic nerve; T.II, second thoracic nerve. (From Kuntz: Autonomic Nervous System, Lea & Febiger.)

The patients upon whom we performed these operations were all disabled. The first case was that of a man who could not

walk without assistance or feed himself. The second patient was not able to work because of great exaggeration of symptoms after a short period of exercise. The third patient was able to walk only a short distance without assistance.

CASE REPORTS

Case 1. A man, twenty-five years of age, entered the hospital on August 1, 1930. The essential points in his history were that he had had chorea at the age of seven and at the age of eighteen an illness during which he slept continuously for seven days followed by a similar period of wakefulness. Following this illness he had never regained his former health or vigor and since that time had had a tremor of the upper extremities and ataxia. On his admission to the hospital the patient was bedridden and unable to feed himself. He presented the typical parkinsonian facies; all voluntary muscular movements were greatly slowed up and spastic in character; he had a marked tremor of both hands and cogwheel spasticity on passive movements of the arms and legs. Diplopia with nausea and vomiting was present. A diagnosis of chronic encephalitis with parkinsonian syndrome was made.

In addition to general supportive treatment the patient was given tincture of stramonium, minims 30 three times daily, and at the end of one month showed a very remarkable improvement. The muscular rigidity and spasticity had practically disappeared, the tremor was greatly reduced and the patient was able to be up and about the ward and to feed himself. He was discharged from the hospital with instructions to continue taking the tincture of stramonium at home. He was negligent in following his medication, however, and two months later, in December, 1930, he returned to the hospital complaining of a recurrence of all his former symptoms with their previous intensity. He was again placed upon regular dosage of tincture of stramonium and sent home.

In spite of regular medication his symptoms persisted and he again returned to the hospital in February, 1931. At this time there was marked spasticity of both upper and lower extremities; he was unable to arise from a sitting posture or to sit down without assistance and was unable to feed himself; he had a festinating gait and after being placed on his feet could not walk more than 20 feet without falling. There was a tremor of both upper extremities, more on the right than on the left but no tremor of the lower extremities.

On February 27, 1931, under ether anesthesia, a bilateral lumbar sympathetic ganglionectomy was done the second, third and fourth lumbar ganglia on each side being removed. Immediately following the operation and for a period of about seven days thereafter there was postanesthetic relaxation of all extremities fully as great in the upper as in the lower, with a loss of tremor in the upper extremities. After seven days the tremor and spasticity of the upper extremities gradually reappeared, increasing in intensity until at the end of nine days they were as marked as before operation. The muscles of the lower extremities remained flaccid and were soft and relaxed when at rest. The speed with which muscular movements were made was greatly quickened and the spasticity was greatly reduced. When the patient was allowed to walk at the end of three weeks he showed excellent muscular control with improvement in his gait and was able to walk, stop and turn without assistance. Twelve weeks after the operation he was able to run with excellent control.

About four months after operation there was another exacerbation of the encephalitis resulting in marked mental apathy and an increase in tremor and rigidity which became most apparent in the right upper extremity. In four weeks his right elbow had become fixed at a right angle by tonic muscular spasm and it was impossible to flex or extend it either by active or passive motion. This exacerbation did not affect the improvement already obtained in the lower extremities.

His condition remained stationary until September, 1931, at which time a right cervical sympathetic ganglionectomy was done. At this operation we removed the transverse processes of the first and second dorsal vertebrae and resected the first and second ribs. Through this incision the lower cervical and the first and second dorsal ganglia were removed. Immediately following this operation it was possible to flex and extend the elbow with passive motion but there was marked increase in the speed and the amplitude of the tremor. The arm has gradually become more useful and can now be fully extended and flexed although

increased tremor and considerable spasticity still persist. At the present time, more than a year after his first operation, his gait is very satisfactory and he has excellent control both on running and walking. His mother states that he cares for himself even to the extent of often cooking his own meals.

Case II. A colored man, thirty years of age, was first seen in April, 1929, complaining of tremor which was increased on exercise and interfered with his work. He gave a history of having had a severe attack of influenza in 1918 and again in 1926 following which he noticed nervousness and tremor starting in the left hand and arm and gradually progressing to involve the right hand and arm. When he was seen in 1929 there was marked muscular involvement of both upper extremities with tremor of both hands and arms, more on the right than on the left and there was a moderate amount of spasticity to passive motion although voluntary movement was free and easy. The lower extremities showed a spasticity which was in no way disabling. He was placed on stramonium without improvement.

When the patient returned to the hospital in May, 1931, his condition was essentially the same except that the tremor was increased. At this time a right cervical sympathetic ganglionectomy was done. The transverse process of the first thoracic vertebra and the first rib were removed and through this incision the lower cervical and first dorsal sympathetic ganglia were resected with the ramus to the first dorsal nerve. Following this operation there was a postanesthetic cessation of tremor of both arms with muscular relaxation for forty-eight hours. After this period of time there was a return of the tremor on both sides and on the right side there was an increase in the amplitude and speed of the tremor; the difference between the two sides was very marked. Spasticity on the right was still present but less marked than before operation. The tremor on the right seemed to be slower in starting and in reaching its maximum amplitude than before sympathectomy, but once attained both speed and amplitude were greater. The patient also developed Horner's syndrome on the right side with dry skin of the right side of the head, neck, shoulder and arm. There was moisture in the right axilla and over the ulnar side of the elbow which seemed to indicate that sympathetic impulses were coming through either the intercostobrachial nerve from the second ganglion or a connecting ramus from the second ganglion to the first dorsal nerve.

On August 31, 1931, a left cervical sympathetic ganglionectomy was done, the first and second transverse processes and the first and second ribs being removed, through which incision the lower cervical, first and second dorsal ganglia were removed. Immediately following this operation there was again cessation of tremor and spasticity with the development of Horner's syndrome and dry skin including the whole axilla. When the tremor reappeared its speed and amplitude were increased on the left side and resembled that present on the right. At the present time, nine months after the last operation, the spasticity is the same as it was immediately following the operation and considerably less than before operation; the tremor is definitely greater on both sides but the patient is able to perform finer movements with greater control. He can now shave and feed himself and is earning his living at light labor.

Case III. This patient was first seen in 1921. At that time he complained of fatigue and nervousness which had been present since an attack of influenza of one month's duration in 1918. A diagnosis of chorea was made. We saw him again in September, 1931, at which time he presented all the symptoms of post-encephalitic parkinsonism. He was unable to control his gait satisfactorily and could not walk safely without assistance. There was marked spasticity of both upper extremities with tremor, and spasticity of the lower extremities with tremor of the right ankle and foot. The reflexes were hyperactive almost to a point of clonus. In this case we felt that there was involvement of the pyramidal tracts as well as of the basal nuclei.

Bilateral sympathectomy of the second, third and fourth lumbar ganglia was performed under spinal anesthesia of 150 mg. novocaine. On the morning following operation there was no change in the spasticity and tremor of the upper extremities but it was immediately apparent that the tremor of the right foot and ankle was greatly increased and that it now involved the muscles controlling the knee. When at rest, the muscles were plastic and soft. At the end of a week the muscles were still soft but slightly resistant to passive motion and the increased tremor persisted. Three

weeks after operation he was allowed to walk and in spite of his weakness his gait was greatly improved. This improvement has been maintained and he can now walk, run, stop suddenly and turn without assistance. His family recognizes his improvement and is anxious to have the upper ganglia removed. Our experience, however, with increase in tremor following ganglionectomy in his case and in the other cases operated upon, has prevented our advising further operative procedure for the upper extremities.

We are making no attempt to explain the mechanism by which the sympathetic nervous system affects voluntary muscles but our experience with results of sympathetic ganglionectomy has convinced us that it has an influence upon them as far as a spastic disturbance of neuromuscular control is concerned. Whether this influence is direct, due to chemical changes or to vasomotor control, has not been determined and remains a problem to be solved by the future work of physiologists and histologists.

Our observations would indicate that in cases of post-encephalitic parkinsonian syndrome the following results may be expected from sympathetic ganglionectomy:

1. In cases in which spasticity is the predominating symptom, there may be lessening of spasticity and increase in initiation, control and speed of voluntary action.

2. In cases in which spasticity and tremor are both prominent symptoms, there may be a lessening of the spasticity, improvement of voluntary control and increase in the tremor's speed and amplitude.

3. In cases in which tremor is the predominating symptom the tremor may be slower in starting and attaining its maximum amplitude but once the maximum is reached, the speed and amplitude of the tremor may be greater than before sympathectomy.

We believe that interruption of the sympathetic impulses may be suggested as a therapeutic measure in cases of post-encephalitic parkinsonism in which the individual is disabled if the disability is the result of spasticity alone, as is often the case in involvement of the lower extremities, but that it should not be considered in cases in which tremor is a symptom since interruption of the sympathetic impulses increases this tremor and counterbalances any benefits which may be derived from lessened spasticity.

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PARALGESIA: PARAVERTEBRAL BLOCK FOR RELIEF OF PAIN

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WHERE incurable conditions exist, the relief of intractable pain remains one of the chief duties of the physician. The undesirable effects of opiates and their comparative ineffectiveness in many cases need not be discussed. The use of chordotomy in severing the spinothalamic tract may find usefulness in many painful malignancies, but it can be made available to only a few, because of the technical skill required.

Blocking of the peripheral nerve trunk to the area involved when it can be done simply and without risk to the patient becomes a very practicable solution of this problem. Paravertebral injection of alcohol has been used in angina pectoris and has apparently given very satisfactory results in selected cases. Behan advised an interruption of sensory pathways in painful conditions when other methods to obtain relief had proved futile. The same method can be applied at different spinal segments to treat various conditions occurring at the different levels. The term "paralgesia" is used to describe this method whereby analgesia is produced by paravertebral injection.

Pain associated with malignancy wherein one hopes to attain comfort for the remaining months of life, could be treated by this method. Non-malignant conditions wherein rest and physiotherapeutic methods have failed, deserve to have this treatment applied.

This method involves very small risk in comparison with the results obtained. The technique of the operation is not complicated and it can be used in debilitated patients.

Lumbar block was done with favorable results in the cases described here.

TECHNIQUE

In paravertebral lumbar block, the segments which are to be injected are selected, wheals are raised with 1 per cent procaine, 4 cm. from the mid-line on a level with the upper edge of the spinous processes. A 4-inch No. 20 gauge needle is inserted through the wheal, directed forward and about 30° medially to reach the transverse process. The distance the needle is inserted varies with the size and adiposity of the patient. Procaine is continuously injected as the needle is slowly advanced. When the transverse process is reached, the point of the needle is passed above it and advanced 3 cm. farther to reach the nerve. Induction of paresthesia is an indication that the nerve has been reached and that the needle is in an ideal position for injection. Two to 3 c.c. of 1 per cent procaine is then injected in order to palliate the pain of injection of alcohol.

With the needle in place 5 to 10 c.c. of 50 per cent alcohol are then injected. The same technique is used in injecting the nerves of the first to the fourth lumbar spaces. In order to inject the fifth lumbar nerve the needle must be passed beneath the transverse process of the fifth lumbar vertebra.

CASE REPORTS

CASE 1. Mr. A. S., aged seventy-nine, was admitted to the hospital on July 26, 1931 complaining of severe pains in the back in the lumbar region. Pain radiated to hips, groins and lower extremities. He had had a prostatectomy done two and one-half years before. The patient was quite emaciated and had marked tenderness over the spine in the lumbar region.

Roentgen-ray examination showed findings suggestive of carcinoma of the vertebrae, probably metastases from a primary focus at the prostate. During three weeks of the patient's stay in the hospital he was subjected to many physical therapeutic measures to obtain relief, but without avail. Non-specific protein injections by vein were given because of persistence of complaint, but without results. Consequently, paravertebral injection of alcohol was decided on and administered on August 17, 1931.

The relief from pain was immediate and the patient experienced his first comfort in weeks. He was discharged from the hospital five days later, enjoying complete relief from back pain.

The patient died on February 2, 1932 of metastatic carcinoma. There had been no recurrence of back pain.

Case II. Mrs. M. J., aged forty-five, was admitted to the hospital on March 30, 1932, complaining of pain in the back in the lumbar region. She was a quiet stolid woman and was employed as a housemaid. She had been constantly under treatment for diabetes mellitus during the previous two years. She had also complained for some time of abdominal pain in the right lower quadrant. She had had an appendectomy on September 16, 1931, which gave her relief from that symptom.

She began to complain of back pain for about three months previous to the last admission to the hospital. Various remedies had been entirely unavailing.

Examination on admission revealed a middle-aged, well-nourished woman. Heart and lungs were negative, blood pressure 150 systolic and 80 diastolic. There was a cruciate scar in the midline of the upper lumbar region. There was some tenderness on pressure on this area, the site of a carbuncle which had been excised two years before.

X-ray examination showed mild hypertrophic arthritis in the upper lumbar region. Because pain had not responded to other measures the patient was given a paravertebral injection of alcohol in the lumbar region, which gave complete relief. When seen six weeks after discharge from the hospital the pain had not recurred. Another follow-up in October, 1932, revealed that while the patient had not had back pain she had lately had an occasional transient "feeling of tiredness" in the back.

Case III. Mrs. L. N., aged twenty-four, had been admitted to the hospital on previous occasions and had received treatment for metastases from carcinoma of the cervix.

She re-entered at this time on September 12, 1931 complaining of loss of strength and especially of excruciating pain in the lower back. She also had dysuria and difficulty in defecation. She was kept in bed and was comforted by the use of narcotics.

However because her complaint of back pain was persistent she was given a paravertebral injection of alcohol on September 17. On September 18 the patient was fairly comfortable, and made no further complaint of back pain. She left the hospital against advice. However she was readmitted sixteen days later, and expired on October 31, 1931, from cachexia, septicemia, and pyelonephritis.

These cases indicate that the method described is worthy of further trial.

CONCLUSION

Nerve block is advocated for conditions of intractable pain. The term paralgesia is suggested to designate paravertebral block by alcohol injection. Cases wherein this principle was followed by the application of paravertebral lumbar block with favorable results are reported.

SCROTAL GANGRENE

FOLLOWING CLOSED OPERATION FOR HYDROCELE*

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CHICAGO

IT is common knowledge that serious complications or unforeseen accidents may follow any surgical operation. When severe complications or sequelae follow a minor surgical procedure, which might possibly have been prevented, the subject is worthy of comment and discussion.

Nearly all modern textbooks of urology discuss the closed operation for the treatment of hydrocele. The phenol or iodine technique need not be reviewed here but the reader obtains the impression that this closed operation is quite harmless and may be performed without the risk of severe complications.

No attempt will be made here to review the literature. Gibson[1] reviewed all the cases of scrotal gangrene up to 1929 and gives a résumé of the 206 cases on record. From an etiological viewpoint Gibson divides the cases of scrotal gangrene into two large groups.

1. Those with some coincident or antecedent lesion which could readily serve as a portal of entry, such as balano-posthitis, chancre, chancroid, intertrigo, trauma, abrasions, inguinal adenitis, strictures, inflammation of the navel (in infants) spreading to the scrotum, wounds, etc.

2. Those in which no lesion can be discovered to explain the onset of the gangrene, or to act as a portal of entry for bacteria.

It is interesting to note that 50 per cent of the reported cases fall into group 1. Only 7 cases followed minor surgical operations: circumcision (1), varicocele (2) inguinal adenitis (3) and abscess incised (1). No case has been recorded following a closed operation for hydrocele. Either this complication is exceedingly rare, or if the closed operation is used as recommended, the poor results do not find their way into the medical literature.

The following case came under my observation on the twelfth day following a phenol injection for a simple hydrocele of the right tunica vaginalis.

W. T., aged forty-six, came to the Northwestern University Clinic on February 25, 1931 complaining of partial deafness and a hydrocele of four months' duration. Examination revealed a man who was well nourished with no gross abnormal findings except a swelling of the right scrotal sac. This mass was average size, tense, not tender, smooth and readily transmitted light. The right testicle was included in the mass. The prostate was normal to palpation but the secretion contained an increase number of pus cells with clumps. The urine was normal except that the first glass contained a few long shreds and pus cells. A diagnosis of the right hydrocele and chronic prostatitis was made. Because the swelling had been aspirated six weeks previously, he was advised to enter the hospital for a hydrocelectomy.

The patient was not seen again until midnight of March 12, when he entered the Passavant Memorial Hospital as an emergency case. He gave a history of having been advised by a friend to see a physician who could cure him "without the use of the knife." This closed operation was performed in the physicians' office. He stated that he experienced very little pain but swelling of the scrotum began immediately after the injection and continued for several days. A consultant was called on the twelfth day, who advised immediate hospitalization.

Examination of the patient in the hospital revealed a sick toxic man, who emanated a foul odor. The scrotum and the penis were enormously enlarged and appeared inflamma-

[1] Gibson, T. E. *J. Urol.*, 23: 125, 1930.

* From the Department of Urology, Northwestern Medical School and the Passavant Memorial Hospital, Chicago.

tory. The lower half of the scrotum was gangrenous with a definite line of demarcation. The temperature was 102°F., pulse 110 and respirations 22. The white blood count was 12,000. He was immediately removed to the operating room and under gas-ethylene anesthesia, the lower sloughing half of the scrotum was removed. There was an infectious necrosis involving the entire scrotum and subcutaneous tissues. The infection had followed Colles' fascia anteriorly and involved the lower half of the abdominal wall similar to a urinary extravasation. The perineum adjacent to the scrotum had sloughed, leaving part of the bulbous urethra entirely exposed. There was considerable induration about the rectum indicating that the infection had broken through the posterior attachment of Colles' fascia and involved the perirectal tissues. An external urethrotomy was easily performed over a sound at the exposed portion of the bulb. The urethra after cutting was found to be normal. A temporary perineal catheter was left in place. The remainder of the serotum, perineum, perirectal tissues and abdominal wall were treated by multiple incisions and drains. Similar incisions were made along the shaft of the penis. Closure was not attempted. The testicles were entirely exposed following the debridement. Postoperatively, the wound was irrigated with Dakin's solution twice daily. During the convalescence, the scrotal edges were repeatedly freed from the testicles. After five weeks, there was sufficient regeneration to allow almost a complete enclosure of the testicles with the aid of secondary silkworm gut sutures and skin clips. After seven weeks the patient was discharged from the hospital with the scrotum almost entirely regenerated.

Fig. 1. Photograph taken twelve hours after debridement. Gangrene of scrotum with exposure of testicles.

Fig. 2. Taken twenty days later. Partial regeneration of scrotum. Partial slough of perineum seen below scrotum.

Fig. 3. Six months later. Scrotum normal except slight retraction of median raphe.

The urethral fistula closed following the passage of two urethral sounds. The urine remained cloudy and was loaded with pus cells. Cultures made at the time of operation revealed a

mixed infection. Subcultures revealed a heavy growth of hemolytic streptococci, Staphylococci albus and aureus, and a Gram negative spore-forming bacillus which did not conform to the common pathogens. Five months later, the patient was cystoscoped for his persistent pyuria and backache. Cystoscopically an upper tract infection was found, particularly in the left kidney. Catheterized renal specimens on culture revealed a heavy growth of B. coli. Smears stained for tubercle bacilli and guinea pig inoculations gave negative results. He was given follow-up treatment for his prostatitis and eight months after his operation he felt greatly improved and his urine became grossly clear.

Sporadic articles appear in the literature recommending closed operations for obliteration of hydrocele sacs (Gray,[2] Pybus,[3] Vedsey[4]). It is entirely possible that there may be cases where the closed operation might be indicated. However, where the open operation is so very simple under gas or local anesthesia, it would seem that this method should be preferred. Hemorrhage and sepsis are the most frequent complications in scrotal surgery. Introducing a trocar or needle into a scrotal sac may carry bacteria into it, particularly if the site of the puncture is not adequately prepared surgically. Improper surgical preparations are more apt to occur in a physician's office than in a hospital.

[2] Gray, G. B. D. *Brit. M. J.*, 1: 649, 1930.
[3] Pybus. *Brit. M. J.*, 1: 239, 1930.
[4] Vedsey, B. R. *Atlantic M. J.*, 29: 47, 1925.

SUMMARY

1. A case report of scrotal gangrene following a closed operation for a simple hydrocele is presented.

2. The closed operation may not always be performed without complications, especially in the hands of the inexperienced operator.

3. Open operation performed under the best surgical surroundings is the best treatment for a simple hydrocele.

TRANSURETHRAL PROSTATIC RESECTION

TECHNIQUE AND RESULTS IN 205 CASES*

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ROCHESTER, MINN.

THE history of transurethral resection has been adequately written by such authors as Davis, Caulk, Braasch and Bumpus. These writers have considered the development of various instruments for relief of obstruction of the vesical neck and one quickly realizes, from reading their contributions, that great credit should be given to instrument manufacturers, physicists, and electrical engineers, as well as to physicians, for the present status of the transurethral operation. I believe that the greatest credit among physicians, for the present momentum acquired by this procedure, is due Caulk and Davis, for beyond any question of doubt they possessed rare courage in insisting that more and more cases of prostatic hypertrophy were suitable for this type of surgical treatment.

SELECTION OF CASES

By careful study and cooperation at The Mayo Clinic, application of the operation has gradually been extended until at the present time I am firmly convinced that the tissue causing urinary obstruction can be adequately removed in any case in which it is possible to pass an operating instrument. Not only do I believe that this is feasible but also that it is desirable. The technical difficulties are often marked in operating on the larger glands, but the very low mortality rate and good immediate results justify the effort expended during even the most tedious transurethral operation. The contention that it is too early to determine the so-called end-result in these cases in which there is considerable hypertrophy cannot be denied. However, the relief afforded to many patients, with negligible risk and discomfort, causes even the most bitter opponent of the method to hesitate in urging prostatectomy.

At The Mayo Clinic, from January 1 to October 1, 1932, 205 patients were operated on by the transurethral route, compared with 37 on whom prostatectomy was performed. These figures correspond, respectively, to 84.7 per cent and 15.3 per cent. According to recent experience, it seems probable that some of those who submitted to prostatectomy could have been relieved by transurethral resection, for prostatectomy has not been necessary in the last three months. Not only has it been possible to reduce the percentage of cases in which prostatectomy is necessary but it also has been possible to accept as constituting suitable risks, many patients in extremely poor physical condition; some have had such associated conditions as heart block, angina pectoris, extreme hypertension, severe diabetes, renal insufficiency of marked degree, and others have been extremely old. Urinary function has been restored to many patients who had been wearing suprapubic tubes or leading a catheter life for periods up to three years rather than face the great risk of prostatectomy. This has brought joy to many a recluse, who once again can be welcomed in any social gathering.

Evidence of the type of risk encountered in the first 205 cases in which operation was performed in 1932 can be noted by referring to Table I. That the majority are beyond the sixth decade of life can be seen in Table II. The relief afforded in many cases of otherwise inoperable carcinoma of the prostate gland has been gratifying.

* Read before the North Central Branch of the American Urological Association, Detroit, Mich., Oct. 28, 1932.

Of the 205 patients, 11.7 per cent had carcinoma.

TABLE I

TYPE OF RISK ENCOUNTERED IN 205 CASES

Accompanying Condition	Per Cent of Cases
Age more than 70 years	19
Diabetes mellitus	7
Systolic blood pressure more than 160 mm. of mercury	28
Severe coronary sclerosis	11
Heart block	3
Cardiac lesions other than heart block, including angina pectoris	4
Parkinson's disease, pituitary tumor, hepatic cirrhosis, asthma	0.5

TABLE II

AGES OF PATIENTS*

Age, Years	Cases	Per Cent
35 to 40	2	0.97
40 to 45	4	1.95
45 to 50	6	2.92
50 to 55	14	6.82
55 to 60	38	18.53
60 to 65	56	27.31
65 to 70	46	22.43
70 to 75	29	14.14
75 to 80	7 (39)	3.41 (19.20)
80 to 85	3	1.46

* Youngest patient, thirty-five years of age; oldest, eighty-seven years of age.

PREOPERATIVE PREPARATION

Preliminary suprapubic drainage has been necessary for numerous patients with severely injured kidneys. In some cases, several months of drainage were necessary before the value for urea became stabilized at a point below 100 mg. for each 100 c.c. of blood. Such patients would constitute very poor risks for a primary transurethral procedure. Very badly infected bladders, with or without diverticula, in most instances have been cared for by preliminary suprapubic operation. It has been found necessary to do this operation in 17.5 per cent of the 205 cases.

Preliminary drainage by inlying urethral catheter has been thought desirable for a steadily diminishing number of patients. In only one case of five is such drainage now being applied, and in these for periods of from two to five days; only rarely is drainage continued for as many as ten days. Not only does it seem unnecessary, but also undesirable unless there is marked urinary infection or residual urine of more than 5 ounces (150 c.c.). Patients who have diabetes and other severe associated conditions are given the usual preoperative medical care. Preliminary medication has not been given for any cardiac lesion.

TECHNIQUE OF OPERATION

Although all of the better known instruments on the market are available at the clinic, the one I employ in the majority of cases is the Braasch-Bumpus punch, which recently has been greatly modified and improved. The principal objection to this instrument is that it has no lens system, and operators familiar with lens instruments are therefore confused. Some detailed description seems indicated.

When making an examination of the vesical neck with an endoscope, or direct vision cystoscope, one must keep several points in mind. For one thing, it must be realized that since the caliber of the instrument is too small to permit visualization of the contour of the neck of the bladder in a single endoscopic view, the conclusion as to the type of obstruction can be drawn only after studying the entire circumference in multiple views.

While recognizing the value of the writings of Randall in regard to the existence of the subtrigonal, subcervical

and Albarran types of glands and the part they probably play in the production of obstruction at the vesical neck, I believe less confusion will result in this paper if reference is made only to the median and lateral lobes.

Endoscopy is facilitated by looking for the three "angles" or clefts produced in the normally round contour of the internal sphincter by hypertrophy of the various lobes. If only the so-called median lobe is enlarged, two definite clefts will be produced at the points of union of the median lobe with the lateral walls of the urethra or with the continuation of the sphincter, as in Figure 1 A. Each actual field, as seen in the six or seven different fields of the endoscope, can be determined from the superimposed sketch in Figure 1 B. If these clefts, x and y, are present, they indicate enlargement of the median lobe and one can get some idea of the size of the lobe by noting the degree of angulation; that is, by noting whether the angle is acute or obtuse, as in Figure 1 C and D.

Among other data of value in determining the size of the lobe are its width, as noted in the distance traversed by the beak of the cystoscope in going from point x to point y, and its length, as noted in the distance traversed from the internal urethral orifice to the verumontanum, as indicated in Figure 2 A. Another point of value is the relative ease with which the urethral meatus and interureteric ridge can be visualized, for it can be well recognized by studying Figure 2 B that if considerable pressure need be exerted to visualize the interureteric bar, or if even marked pressure fails to reveal it, then considerable enlargement of the median lobe exists.

From this study of the two angles referred to, the distance from the sphincter to the verumontanum, the width of the lobe, and the pressure required to visualize the ureteral ridge, a fairly accurate estimate of the size of the median lobe can be made.

When the lateral lobes are hypertrophied the deformity produced in the contour of the circumference of the vesical neck will depend on whether the enlargement of the lateral lobe extends principally into the bladder or principally into the urethra. In the case of the former another cleft or angle will be produced at 12 o'clock in the sphincter, and the degree of encroachment of the lobes can, in some measure, be estimated by the degree of the angle, just as described in the case of the median lobe (Fig. 3 A, B, C).

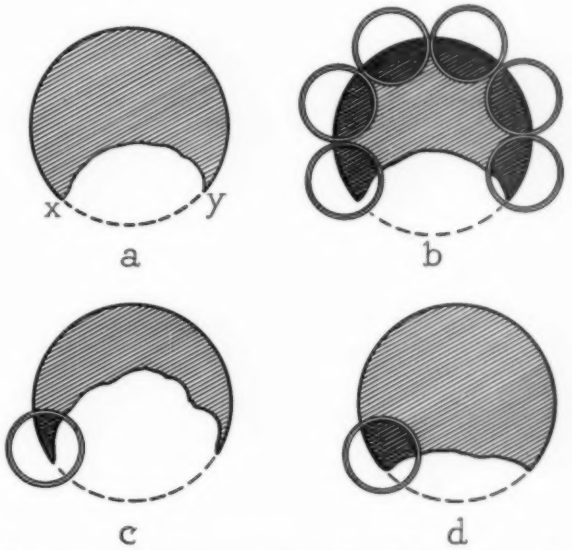

Fig. 1. A. Enlargement of median lobe with angles x and y between lobe and lateral edge of sphincter. B. Multiple endoscopic views necessary to visualize entire circumference. C and D. Difference in degree of angle produced by lobes of different sizes.

The amount of extension into the bladder, or the length of the lobes, can be estimated fairly well by the distance traversed from the edge of lobes at the internal urethral orifice out to a point in the urethra just opposite the verumontanum, but their thickness or width cannot be estimated with a direct vision instrument. This should be done with an instrument equipped with a retrograde lens system, and it is only with such an instrument that one can obtain an accurate idea of the amount of tissue projecting into the bladder.

Intra-urethral enlargement of the lateral lobes can be studied very well with the direct vision instrument. The approximation of the lobes, their length, that is, the distance from the internal urethral orifice to the verumontanum, and their anteroposterior diameter, that is, the distance from the roof of the prostatic urethra to the floor, are all to be determined before making an estimate of the size of the lobes. Thus, to sum up, there are five landmarks which should be studied; namely, the three angles mentioned, the ureteral ridge, and the verumontanum. Keeping these in mind, noting the distance traversed by the end of the cystoscope in visualizing them, and studying the tissue as it folds into the field of vision, one can get a very good impression of the type of enlargement. There are of course numerous variations; the so-called commissural hypertrophy, overlapping types of hypertrophy, unilateral hypertrophy of lobes and the various fusions of the lobes, as well as the occasional hypertrophy of the anterior lobe; these produce modified endoscopic views in each instance. By careful, rapid study, it should not take more than a few minutes to determine all the points outlined, and a skillful endoscopist will have little trouble noting the tissue which is causing urinary obstruction.

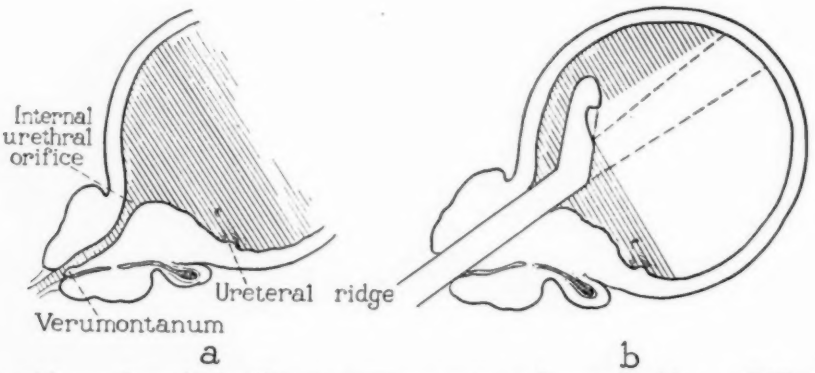

Fig. 2. A. Relation of internal urethral orifice to verumontanum and ureteral ridge. B. Difficulty in visualizing interureteric bar (ureteral ridge) in presence of marked hypertrophy of median lobe.

Fig. 3. A. Normal round sphincter. B. Moderate hypertrophy of lateral lobes. C. Marked hypertrophy of lateral lobes.

No matter which of the numerous instruments on the market for transurethral resection is used in performing the operation, the purpose to be accomplished is removal of the obstructing tissue. This tissue can arbitrarily be divided into the intravesical portion and the intra-urethral portion; one can be present without the other; a combination of both is most common.

Failures in the operation usually can be attributed to not recognizing, and hence not removing, one or the other portion of obstructing tissue, or in not resecting widely enough. Figure 4 A and B is a diagrammatic representation of lateral and anterior cross sections of the intravesical and intra-urethral obstructing prostatic tissue usually encountered.

If one wishes to obtain the best possible early postoperative result, the tissue which is intravesical, as indicated by the diagonal lines, must be entirely removed. In doing this a portion of the anterior half of the trigone can be safely cut away, and of the lateral lobes, intravesically, all of the tissue should be resected until the lateral

edge of the prostatic urethra is flush with the wall of the bladder, as indicated in Figure 4 C and D.

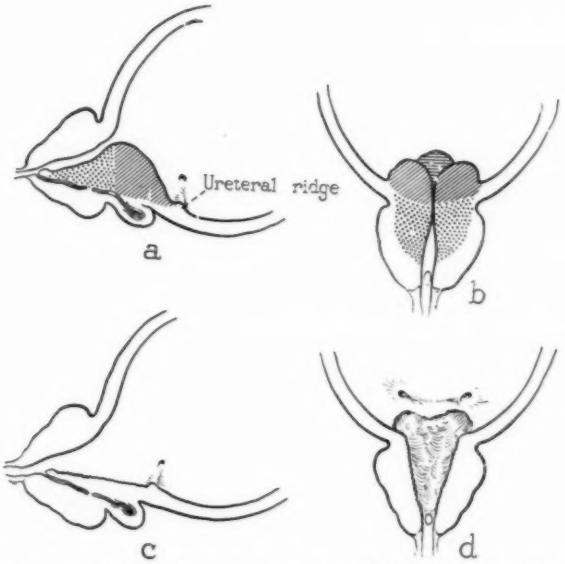

Fig. 4. A. Sagittal section, diagonal lines representing intravesical obstructing tissue, dotted areas intra-urethral obstructing tissue. B. Anteroposterior section. C and D. After removal of obstructing tissue.

If any tissue is left, more or less residual urine may persist after the operation, until shrinkage of the tissue and absorption of edema takes place. Adequate removal of the intra-urethral portions, indicated by the dotted areas in Figure 4 A and B, makes for ease in voiding, and inadequate removal in these areas will result in the patient's being able to empty his bladder only by exerting pressure, often with accompanying vesical tenesmus and spasm.

In removing the tissue designated, the operator should always visualize the verumontanum before starting the operation, and should be on the alert to visualize the ureteral ridge and meatus as early as possible in the procedure. With these landmarks kept in mind, pieces of tissue can safely be removed from any area shown in the shaded portions in Figure 4 A and B. Often, in the case of considerable hypertrophy of the median lobe, one cannot visualize the ureteral ridge or meatus until considerable tissue has been resected, and in such cases one should make certain that the knife or loop has not engaged the posterior portion of the trigone and should

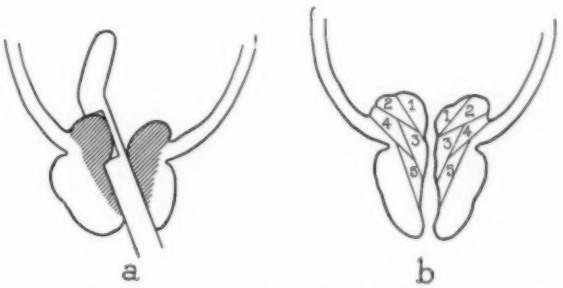

Fig. 5. A. Engagement of first piece of intravesical tissue in instrument. B. Removal of successive pieces of tissue from each lateral lobe.

exert constant vigilance to avoid these structures.

With the Braasch knife punch it is essential, in working on either the median or lateral lobes, but especially in case of the latter, to remove the intravesical portion of the lobe first, as indicated in Figure 5 A and B. Thus, as indicated by the figures in the sections drawn, successive pieces can easily be removed if this is done, for each piece resected forms a slot into which the end of the punch can fit while the tissue closer to the operator is being forced into the fenestra of the instrument. It can, on the other hand, be readily seen that attempts to engage tissue in the urethra while intravesical tissue persists will be relatively unsuccessful, and as a rule mucosa only can be removed.

Usually, in the presence of enlargement of both lateral and median lobes, it is best to remove the lateral lobes first. However, if after one begins this removal the median lobe interferes, it may become necessary to remove that lobe before the entire obstructing portions of the hypertrophied tissue of the lateral lobe can be completely resected.

The use of the multiple needle electrode controls bleeding from all but the larger vessels. The period of coagulation and amount of current will depend on the generator used and the type of gland. The object of this electrode is to desiccate

only the path through which the tubular knife will pass. One should not coagulate too much, for the burned tissue must either slough away or be absorbed, and the post-operative reaction varies to a great extent, in my experience, according to the amount of such tissue present. At any stage in the procedure, when bleeding from the larger vessels becomes troublesome, one can control it with the Bugbee electrode, as described previously by Bumpus.

After removal of the tissue which apparently caused the obstruction, it is well to study the entire field of operation with the guide in place, which closes the fenestra of the instrument. This should be done with as little fluid in the bladder as possible, for if intravesical tension is great, the prostatic urethra may be forced open and tissue which would obstruct with a partially filled bladder, will be forced to the edge of the prostatic cavity and apparently will not obstruct. When one can visualize a clear channel through into the bladder with the end of the instrument placed distal to the verumontanum, sufficient tissue has been resected. Injury to the verumontanum and external sphincter must be carefully avoided or incontinence will result. When all the larger bleeding vessels have been controlled, a number 24 to number 28 catheter is taped in place so that it will remain in the urethra until the urine is entirely clear, usually about forty-eight hours.

POSTOPERATIVE CARE

The immediate postoperative care is highly important. The catheter should be irrigated at hourly intervals for the first six or eight hours, since any serious bleeding usually will occur in that time. Failure to irrigate often enough results in the formation of clots which block the catheter, obstruct drainage, and incite efforts to void, thus causing congestion with increased bleeding. Two or three irrigations a day suffice after the urine is relatively clear. The most trouble with postoperative bleeding has been encountered in cases in which there is associated marked prostatitis. The so-called adenofibromas bleed less, and carcinomas least of all. Forty-eight to seventy-two hours of drainage by catheter is practically always sufficient; occasional patients require only twenty-four hours. One should see that drainage of the urethral secretions around the catheter is not blocked by material caked in the urethral meatus for such neglect will result in marked urethritis and possibly high fever.

It is well to catheterize again for residual urine six hours after the in-lying catheter has been removed. In 70 per cent of cases at The Mayo Clinic there is none. If it measures more than 5 ounces (150 c.c.) and if the patient must strain to void, or is having tenesmus, a catheter is reinserted. Most often, post-operative edema accounts for the difficulty. If after another two or three days of urethral drainage the patient is still unable to void freely, reëxamination usually will disclose obstructing tissue overlooked at the time of operation.

POSTOPERATIVE MORBIDITY AND COMPLICATIONS

Severe immediate postoperative hemorrhage rarely occurs. It has been limited in my experience to a few cases in which a marked sustained drop in blood pressure, due to spinal anesthesia, has occurred during the operation with a resultant bloodless operative site, which began to bleed with the return of normal blood pressure.

In only one case in this series of 205 has it been necessary to control early post-operative bleeding by further electrocoagulation, and in no case has any of the hemostatic bags been employed.

As a rule there is less than a degree rise in temperature. Only patients with associated marked prostatitis have a rise of 2 or 3 degrees. In the 205 cases there were 89 in which temperatures were higher than 101°F. at any time after operation, and in only 18 was the temperature as much as 103°F. After removal of the catheter there is usually very little pain on voiding, and

this comparative freedom from distress persists until the seventh or eighth day, when the sloughs begin to pass and nerve endings are exposed. At this time one can expect an increase in dysuria and discomfort. Such convalescent distress is comparable to that found in tonsillectomy at a like time after operation, and is not a bit more serious.

Severe postoperative hemorrhage after the tenth day has occurred in 5 per cent of cases, and it has been necessary in 6 cases of these 205 to remove clots from the bladder through the cystoscope. In no case has suprapubic cystostomy been necessary to evacuate the clots or control bleeding. Perforation of the bladder, or any other mishap requiring suprapubic operation, has not occurred in the last year following transurethral prostatic resection.

Incontinence has not developed in any case in the series. Epididymitis has developed during the period of postoperative observation in only 8 per cent of the cases.

The period required for complete healing is variable. Cases in which the resection is extensive require a little less than three weeks, most of which time the patient's are ambulatory and do not require care in hospital. By the twenty-first day after operation all the sloughs have come away and the danger of delayed bleeding, in my experience, has passed. In many cases the urine is crystal clear and cultures are negative.

FAILURE OF THE OPERATION

In 89.5 per cent of the 199 new cases in this series of 205 consecutive cases relief was afforded by one transurethral resection. Two, and in a few instances three, resections were done in the other 10.5 per cent. In no case of these 205 has prostatectomy been necessary after transurethral operation failed. Five patients (2.4 per cent) had undergone prostatectomy previously.

MORTALITY RATE

There were no deaths in this series. The last death following transurethral resection occurred in 1931. Since then, to October 1, 1932, 236 patients have been operated on without a fatality.

RECURRENCE

It is of course too early for true recurrence to have developed in these cases. This series of 205 cases, encountered in the first nine months of 1932, includes one patient operated on the second time early in January, the first operation having been done in the last week of 1931. Only five can be classed as cases of recurrence. Three of these patients had benign hypertrophy for which punch operations had been performed three, six and seven years previously. The two others had carcinoma, and resection was performed a second time respectively eight months and thirteen months after the initial operation.

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A REPORT OF

POSTOPERATIVE PULMONARY COMPLICATIONS*

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A STUDY of the postoperative pulmonary complications in the Temple University Hospital during the past fourteen months has been made to determine their frequency and cause. On the various surgical services, 5894 operations have been performed from July 1, 1931 to October 1, 1932, excluding blood transfusions and artificial pneumothorax cases.

TABLE 1

ANESTHETIC AGENTS USED AND LUNG COMPLICATIONS WITH EACH TYPE OF ANESTHESIA

Anesthetic	Number	Number of Lung Complications	Recovered	Died
Spinal	872	5	1	4
Spinal and gas or ether	50			
Gas-oxygen and ether	2542	1	..	1
Gas-oxygen (ethylene or nitrous)	885	2	..	2
Ether	165			
Chloroform	14			
Local	1261	4	1	3
Avertin	104	1	..	1
Amytal	1			
Total	5894	13	2	11

During this period there were 13 proved postoperative pulmonary complications including 8 cases of pneumonia, 2 cases of atelectasis, 2 cases of pulmonary embolism and one case of accidental pleural effusion.

Seasonal influence seemed to play a small part, as there was only one case of pneumonia that could be traced to epidemic infections of the winter months.

From the standpoint of age, eight complications occurred in patients between fifty-five and eighty-four years of age.

The complications resulting in recovery were: one case of atelectasis, in a patient fifty-five years of age, and one case of pneumonia in a patient aged twenty-two.

The complications resulting in death were eleven. In analyzing this group of cases, all deaths occurred in bad risk patients, viz.; patients suffering from severe infections, cardiovascular disease, asthenic senile types and carcinoma. Six of the 7 pneumonia cases recorded were of the terminal type preceding death, in most instances verified by autopsy.

There are two lung complications in the series that deserve special mention. Atelectasis occurred in a female aged fifty-five, upon whom a cholecystostomy had been done for empyema of the gall bladder. The patient had been ill for five days, was dehydrated and showed some evidence of cardiac decompensation. *Local anesthesia was used unaided.* No narcotic was administered. The duration of the operation was one hour. Immediately on return to bed from the operating room, cyanosis, cough and labored breathing was noted. Examination of the chest revealed total absence of breath sounds in the left chest, with over-breathing on the right side. Carbon dioxide and oxygen inhalations were ordered, with improvement in color. *X*-ray examination showed collapse of the left lung with displacement of the heart and mediastinum to the left. Carbon-dioxide and oxygen inhalations were continued for forty-eight hours with

* From the Senior Surgical Service Temple University Hospital. Read before the Staff of Temple University Hospital, October 14, 1932.

rather rapid improvement. *X*-ray examination of the chest, ten days later, showed recovery.

to the right. Sixteen ounces of fluid were aspirated from the left pleural cavity. The child died three days later from

TABLE II
SUMMARY OF LUNG COMPLICATIONS AND TYPE OF OPERATION

Operation	Atelectasis		Pneumonia		Embolism		Pleural Effusion	
	Recovery	Death	Recovery	Death	Recovery	Death	Recovery	Death
Gall bladder	1							
Stomach	..	..	..	2				
Appendectomy	..	..	..	1	..	1	..	1
Laryngectomy	..	1	..	1				
Radical operation for trigeminal neuralgia	..	..	..	1				
Prostatectomy	..	..	..	1				
Ludwig's angina	..	..	..	1				
Hernia	..	..	1					
Amputation of leg for ununited fracture of femur	..	..	..	..	..	1		

The second interesting complication occurred in a boy, twelve years of age, who had been operated upon for perforative appendicitis with peritonitis under spinal anesthesia. The patient was receiving continuous hypodermoclysis of 2 per cent glucose in saline solution in both pectoral regions. Six days after operation, the resident was hurriedly called to see the patient, who was having difficulty in breathing and crying aloud with pain. It was noted that 1000 c.c. of solution had been taken in less than one hour, without engorgement of the tissues, and that the left chest was flat on percussion, with absence of breath sounds. Believing that fluid had entered the pleural cavity, an emergency *x*-ray examination was ordered, which showed a large amount of fluid in the left pleural cavity, with the heart and trachea displaced nearly 3 cm. sepsis due to perforative appendicitis and peritonitis.

STATISTICS FROM OTHER HOSPITALS

Lyons,[1] reporting upon 6619 operations under general anesthesia in the Presbyterian Hospital, Chicago, covering a period from 1921 to 1930, noted that pulmonary complications occurred in 63 patients. Pneumonia occurred in 29 patients, bronchitis in 21. There were no cases of postoperative atelectasis diagnosed. Sixty-one and nine-tenths per cent developed lung complications in the winter months; 34.9 per cent of complications followed upper abdominal operations.

Fuller[2] analyzed the surgical records of the University College Hospital, London, for the year 1927 and found 124 pulmonary sequelae in 1478 cases, a percentage of 8.3; the mortality was 1.8 per cent. There

were 75 cases of bronchopneumonia, a larger number, he pointed out, than in any of the recently published series. The series contains 9 cases of infarction; this complication, he says, never occurs before the seventh day.

Sise,[3] after compiling statistics of several observers including Brunn and Brill, Foss and Kupp and others, showed that the percentage of complications are practically the same under spinal or ether anesthesia for all types of operations. Sise then combined statistics of these observers including those of the Lahey Clinic and found that for upper abdominal operations under spinal or gas anesthesias, twice as many complications occurred under ether anesthesia. For lower abdominal operations no practical difference was noted between the two anesthetics.

ETIOLOGY

It is evident that respiratory complications follow all types of anesthetics. Mikulicz has said that lung complications occur as frequently after local as after general anesthesia. In this report 30 per cent of complications occurred with local anesthesia. It is apparent that the severity of disease and the operation are the main factors in the production of lung complications. Other probable causes as outlined by Lyons[1] are pre-existing cardiac or pulmonary disease; poor mouth hygiene; cooling-off of the patient; aspiration of stomach contents; decrease in expectoration and poor ventilation of the bases because of pain; disorganization of the abdominal pump mechanism by an abdominal incision producing a tendency to stasis in the splanchnic vessels which predisposes to thrombosis; and pneumostasis from the patient lying continually in the dorsal position. In her experience bronchitis is more likely to occur in heavy smokers than in those who do not smoke or smoke only moderately.

Foss and Kupp[4] believe that embolism plays the chief part in the production of most of these complications. They affirm that infarctions (minor emboli) are far more common than has been generally supposed.

Many theories have been advanced and much experimentation has been done by the group believing that most complications are atelectatic in origin. Their conclusions are largely drawn from upper abdominal operations where the respiratory mechanism is placed under a distinct handicap. It is in this type of case that the untoward effects, as pointed out by Brill and others[5] may be counteracted in part by carbon dioxide and oxygen inhalations.

COMMENT

For all types of patients it seems that individual care before, during, and after the operation is paramount.

As a corollary it seems that the shortest operation, the least handling of tissues, the maintenance of body heat, and support to the circulation are all important issues to be considered in fortifying patients against these complications.

When complications do arise, the early recognition by all available diagnostic aids is to be sought for, so that appropriate treatment may be instituted.

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ENCEPHALOGRAPHIC STUDIES IN EPILEPTIFORM SEIZURES*

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COLUMBUS, O.

ENCEPHALOGRAPHY as a diagnostic procedure in certain obscure intracranial conditions has demonstrated a variety of pathological lesions, the probable cause of the convulsive state.

In a study of 114 patients by this method presenting symptoms of intracranial disease, 26 gave a history of major convulsive seizures.

The following report is based upon an analysis of 8 convulsive cases demonstrating the several probable causes encountered in this series.

BRAIN TUMORS

Brain tumors may be responsible for epileptiform convulsions. Sargent[1] reported that convulsions occurred in 30 per cent of the 270 cases which he studied. H. L. Parker[2] recently studied 313 cases of intracranial tumors at the Mayo Clinic and of these 21.6 per cent were found to have had major epileptiform seizures. N. Gotten[3] presents 3 cases of brain tumor, disclosed in the routine encephalographic studies on epileptic patients, in which the only prominent symptom was convulsions.

In 2 patients of this group the encephalograms presented evidence of brain tumor. The diagnosis was later confirmed by operation.

Case 1. Z. T., aged forty-eight, white, female, was admitted to the University Hospital January 8, 1931 to the service of Dr. V. A. Dodd.

Chief Complaints. Convulsions and headache.

Family History. Negative.

Past History. Not remarkable.

Present Illness. The first seizure occurred four years ago. The patient states that she has always been nervous but denies convulsions prior to the present illness. Since the onset in 1927 attacks have occurred every three or four months. During the past three months headaches have been present almost daily. During an attack the patient loses consciousness and the head and eyes deviate to the left. Following an attack there is a very definite weakness of the left arm and leg.

Physical Examination. The general physical examination was negative.

Neurological examination revealed the station, gait and coordination as normal. Reflexes of the right and left side were increased; no clonus, no Babinski sign. The left side was slightly weaker than the right. There was a marked supranuclear weakness of the left face. Eye grounds and visual fields were examined by Dr. A. D. Frost on January 11 and reported as normal. The results of the laboratory examinations were: Wassermann reaction of the blood and the spinal fluid, negative. Examination of the urine negative.

On January 13, 1931 an *encephalography* was performed. The cerebrospinal fluid pressure was 14 mm. Hg. A total of 70 c.c. of fluid was removed and replaced by 70 c.c. of air. Roentgenograms revealed a shift of the midline structures to the left.

Diagnosis: Brain tumor of the right midfrontal area.

On January 26 a right-sided osteoplastic craniotomy was performed. A tumor was exposed in the posterior part of the middle frontal convolution. The tumor, 2.5 cm. in diameter, containing a small cystic cavity, was completely removed by means of the endotherm.

Microscopic Diagnosis: Astrocytoma.

Case 11. E. S., aged thirty-six, white female, was admitted to the University Hospital April 19, 1931 to the service of Dr. G. I. Nelson.

Chief Complaint. Convulsions.

Family History. Negative.

Past History. Not remarkable.

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Present Illness. For the past two and a half years the patient had had convulsive seizures. They had gradually increased both in frequency and in intensity. It was stated that she had not complained of headaches. A few hours before admission to the hospital the patient was seized with a convulsion. The entire body was involved. Since that time she had had convulsions, averaging about four per hour, each lasting about two minutes.

FIG. 1. Case I. Midline structures are displaced to left by tumor mass.

FIG. 2. Case II. Roof of ventricle on right is displaced downward by tumor mass. Note slight shift of midline structures to left.

General physical examination was negative. Blood pressure was 140/60.

Neurological examination revealed increased reflexes on the left side; no clonus or Babinski sign. The muscle power was diminished on the left side. A definite supranuclear facial weakness was noted on the left side. A convulsion was observed in which the left arm was flexed, the fingers of the left hand exhibited convulsive movements. The head and eyes were turned slightly to the right. Coordination was normal.

Examination of the eyegrounds by Dr. A. D. Frost showed bilateral papilledema, slightly greater on the right. The visual fields were normal. The Wassermann reaction of the blood was negative. Urine examination was negative.

April 15, 1931 *encephalography* was performed. The pressure of the cerebrospinal fluid was found to be 27 mm. Hg. A total of 50 c.c. of fluid was removed and replaced by 45 c.c. of air.

Examination of the encephalograms showed a slight shift of the midline structures to the left. The roof of the lateral ventricle on the right was displaced downward.

Diagnosis: Brain tumor of the right precentral area.

April 16, 1931 an osteoplastic craniotomy was performed on the right. The tumor was found to be subcortical and deep seated. The patient's condition did not warrant an attempt at enucleation. A decompression opening was made in the subtemporal region and the wound closed. The patient's postoperative course was stormy and death occurred two days after operation. Autopsy was performed and a spongioblastoma multiforme was demonstrated, the diagnosis confirmed by microscopic examination.

PORENCEPHALY

Jaffe[4] defines the condition as a funnel-shaped defect of the brain which extends from the surface of a hemisphere close to or into the lateral ventricles. The preponderance of evidence emphasizes the importance of trauma as an etiological

factor in the causation of this pathologic phenomenon. McClintic[5] considers the condition a sequel to birth injury, ascribing

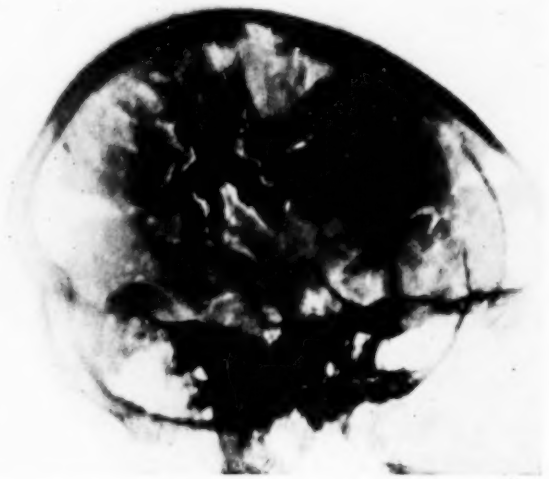

Fig. 3. Case III. Frontal atrophy with increase in subarachnoid pathways. Cone-shaped defect in parietal region.

the bilateral type to periventricular hemorrhage and the cortical type to "superficial hemorrhage."

One patient presented encephalographic evidence of this interesting condition. Although this lesion is considered to be quite rare, it would seem that with the increasing use of encephalography it will be discovered more frequently than in the past. The lesions according to Jaffe occur in certain locations in the following order of frequency: Central convolutions, insula of Reil, parietal region and finally in the occipital lobe. The defect occurred in the parietal lobe in our patient.

Case III. A. T., aged thirty-eight, white male, laborer, was admitted to the University Hospital, May 27, 1931 to the service of Dr. LeFever.

Chief Complaint. Convulsions.

Family History. Negative.

Past History. General health had always been good. There was no history of accidents.

Present Illness. The patient began having attacks of unconsciousness at the age of twenty. For the past two years they had been occurring with increased frequency. The patient stated that the attacks are instituted without warning, and that he did not always fall. During the past six months he had fallen during an attack more often than formerly.

Fig. 4. Case IV. Bony depression in left temporal region. Displacement of inferior part of left lateral ventricle to right. Subarachnoid pathways over cortex decreased in number.

He usually lost control of the bladder sphincter.

General physical examination was negative. Blood pressure was 125/60. Eyegrounds were normal. Neurological examination was normal. Blood count and urine examination were negative. Blood Wassermann reaction was negative.

May 28, 1931 an *encephalography* was performed. The cerebrospinal fluid pressure was found to be 8 mm. Hg. A total of 65 c.c. of fluid was withdrawn and 60 c.c. of air was injected.

Interpretation of the plates revealed a marked amount of cortical atrophy, especially over the frontal region and a general increase of the subarachnoid markings. The cone-shaped defect occupied a position in the left parietal area, extending down to, but not communicating with, the lateral ventricle.

Diagnosis: Porencephaly.

POST-TRAUMATIC CONVULSIONS

The principal causes for epileptiform seizures following trauma are depressed fractures, arachnoiditis, either with or

without atrophy of the brain, and cortical scars. Convulsions in two of our patients followed severe trauma.

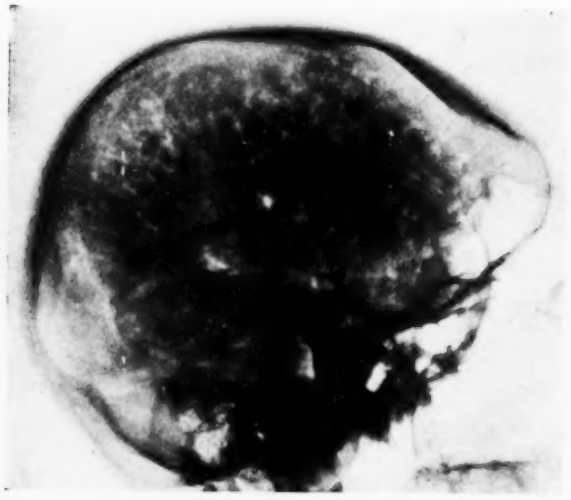

Fig. 5. Case v. Cortical atrophy. Generalized increase in sizes and number of subarachnoid pathways. Increase in bony density over right frontal area.

Case iv. D. S., aged twenty-two, white male, farmer, was admitted to the University Hospital February 20, 1931 to the service of Dr. V. A. Dodd.

Chief Complaint. Headache and periods of unconsciousness.

Family History. Negative.

Past History. Not remarkable.

Present Illness. One year ago patient was riding in an automobile when he was struck in the left temporal region by a guard rail at a railroad crossing. He was rendered unconscious by the impact and was taken to a hospital where he remained thirteen days. At the end of this time he was taken home and instructed to remain in bed for another week. Five months after the injury he became unconscious and remained so for eighteen hours. Two months prior to admission he had another attack of unconsciousness and was stuporous for twelve hours. Each time he had an aura of the oncoming attack.

General physical examination was negative except for a bony depression over the left temporal region. Blood pressure 110/76.

Neurological examination revealed a slight nystagmus when the eyes were turned to the left. Slight supranuclear facial weakness on the right. The eyegrounds were normal. The reflexes on the right side were more active than upon the left.

Blood count and urine examination were normal. Wassermann reaction of the blood was negative.

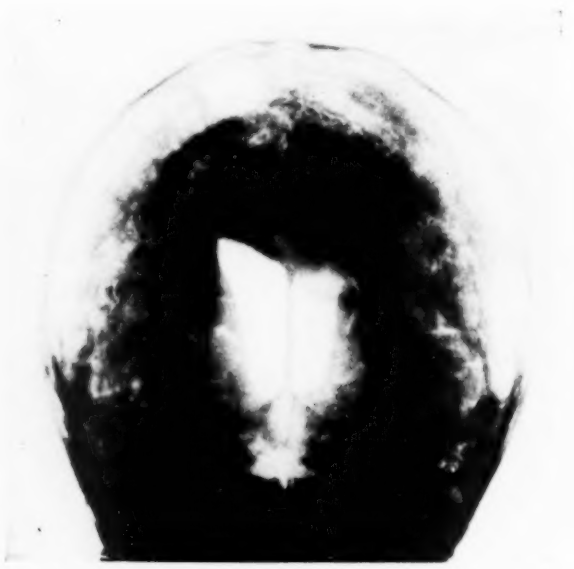

Fig. 6. Case vi. Marked cortical atrophy. Increase in size of subarachnoid pathways. Enormous enlargement of third, fourth and lateral ventricles.

February 26, 1931 an *encephalography* was performed. The cerebrospinal fluid pressure was found to be 22 mm. Hg. A total of 85 c.c. of fluid was removed and 80 c.c. of air injected.

The roentgenograms revealed a bony depression in the left temporal region. The inferior part of the left lateral ventricle was displaced toward the midline. The subarachnoid markings over the cortex were markedly decreased in number.

Diagnosis: Depressed fracture of the left temporal bone, arachnoiditis and increased intracranial pressure.

March 3, 1931 the diagnosis was confirmed by operation and the depressed area of bone was removed.

Case v. P. D., aged thirty-two, white male, fireman, was admitted to the University Hospital August 11, 1930 to the service of Dr. V. A. Dodd.

Chief Complaint. Headaches and convulsions.

Family History. Negative.

Past History. No serious illness or injury prior to the present illness.

Present Illness. On June 3, 1929, the patient fell from a ladder, a distance of about 20 feet, striking on the head and shoulders. He was rendered unconscious and taken to a hospital. He was unconscious for twelve hours. During the next few days he had four generalized convulsions. The patient was discharged June 7. From that time until the present admission, he has had a constant, throbbing headache. In the past year he has had five attacks of unconsciousness, each one lasting about one hour. An aura accompanied each attack.

Fig. 7. Case vii. Cortical atrophy. Increase in size and number of subarachnoid pathways. Interhemispheric atrophy. Lateral ventricle of right side much larger than opposite. Third ventricle inclines to right.

Fig. 8. Case viii. Subarachnoid pathways not enlarged. Enormous enlargement of lateral ventricles with moderate enlargement of third and fourth ventricles.

General physical examination was negative. Blood pressure 130/70.

Neurological examination revealed bilateral blurring of the nasal discs. There was slight increase of the reflexes on the left side; a weakness of the left arm and a tendency to drag the left leg. Station and coordination were normal. Babinski sign was negative.

Encephalography was performed and the cerebrospinal fluid pressure was found to be 20 mm. Hg. A total of 80 c.c. of fluid was removed and replaced by 75 c.c. of air. The encephalograms revealed an atrophy of the frontal lobes, a general increase in the size and number of the subarachnoid pathways. Over the frontal area on the right side there appeared to be a thickening of the bone, especially the inner table.

Diagnosis: Cortical atrophy, increased intracranial pressure and bony compression over the right frontal region.

August 17, 1930 a right-sided osteoplastic craniotomy was performed. The bone was found to be greatly thickened and somewhat sclerosed. There was evidence of arachnoiditis and a marked enlargement of vessels was encountered over the cortex. The number, size and arrangement of the veins were suggestive of venous angioma.

COMBINED EXTERNAL AND INTERNAL HYDROCEPHALUS

Pendergrass[6] states that if the pacchionian bodies and subarachnoid villi eliminate the major portion of the cerebrospinal fluid, then anything that disturbs the elimination of the cerebrospinal fluid ultimately tends to cause external and internal hydrocephalus. The subarachnoid pathways or fluid spaces are first to suffer behind the point of obstruction. These dilate, and the back pressure is next transmitted to the basal cisternae, and then finally to the fourth, third and lateral

ventricles in order. The last being the least affected as a rule. One patient presented evidence of this lesion.

Case VI. F. A., aged nine, white female, was admitted to the University Hospital January 19, 1931 to the service of Dr. Baxter.

Chief Complaint. Convulsions.

Family History. Negative.

Past History. According to the mother, the child had never had an acute infectious disease; no injuries.

Present Illness. At the age of twenty-seven months the patient had her first convulsion which lasted about six hours. Six months later, she began having "staring spells" which would last for a few seconds only. During the past six months the patient had had a generalized convulsion every three or four days. She stated that she had no warning of the oncoming attack. During an attack there was loss of control of the bladder.

General physical examination was negative. The circumference of the head was normal for the age.

Neurological examination was negative. Eyegrounds were normal.

Urine and blood count were normal. Wassermann reaction of the blood was negative; spinal fluid negative, calcium 12.9, phosphorus 2.55.

February 23, 1931 an *encephalography* was performed and the cerebrospinal fluid pressure was found to be 8 mm. Hg. A total of 40 c.c. of fluid was removed and replaced by 40 c.c. of air.

Interpretation of the encephalograms revealed a marked amount of bilateral cortical atrophy. The subarachnoid pathways were considerably enlarged. The third, fourth and both lateral ventricles were enormously dilated.

Diagnosis: Combined internal and external hydrocephalus.

BILATERAL EXTERNAL AND UNILATERAL INTERNAL HYDROCEPHALUS

Pendergrass[6] has demonstrated one case of dilatation of one of the lateral ventricles. He assumed that the affected ventricle was blocked at the foramen of Monro for sufficient time to cause dilatation of the affected ventricle with subsequent brain atrophy. The re-establishment of the circulation was evidenced by the ability to drain and fill the dilated ventricle by the lumbar route. Pendergrass also advances the theory that the condition may follow trauma, in which there has been a subcortical lesion. The healing and subsequent scar contraction causes unilateral dilatation of the ventricle on the affected side. If there has been enough free bleeding to cause generalized obstruction at the points of elimination, the external hydrocephalus may be bilateral. One patient in this series gave evidence of this condition.

Case VII. C. J., aged twenty-one, white male, student, was admitted to the University Hospital June 7, 1931 to the service of Dr. Wagenhals.

Chief Complaint. Convulsions.

Family History. Negative.

Past History. General health had always been good; no serious injuries.

Present Illness. The patient began having attacks of unconsciousness at the age of fifteen. The attacks varied greatly in frequency, on one occasion he had gone a year without an attack. During the past year he had had an attack about once a month. The seizures were generalized and preceded by a definite aura. The convulsions often occurred at night without loss of bladder control.

General physical examination is negative. Blood pressure 112/65.

Neurological examination was negative. Eyegrounds were normal. Urine and blood examination were normal. Wassermann reaction of the blood was negative.

On June 8, 1931 an *encephalography* was performed and the cerebrospinal fluid pressure was found to be 18 mm. Hg. A total of 80 c.c. of fluid was removed and replaced by 75 c.c. of air.

Examination of the encephalograms revealed a considerable amount of cortical atrophy. The subarachnoid pathways were increased both in size and number. There was a marked amount of interhemispheric air. The lateral ventricle of the right side was much larger than its fellow. The right ventricle encroached to a slight extent over the midline. The third ventricle was inclined to the right.

Diagnosis: Bilateral external and unilateral internal hydrocephalus with brain atrophy.

INTERNAL HYDROCEPHALUS

It is infrequent for convulsions to be associated with internal hydrocephalus. The condition may be due to some anomaly or pathologic lesion in the region of the foramina of Luschka and Magendie of long enough standing to cause an internal hydrocephalus and subsequent atrophy of the brain. If the circulation is re-established following some unknown factor then at the time of operation air is enabled to enter the ventricular system. In these cases, the encephalogram demonstrates a uniform dilatation of all of the ventricles without any particular change in the subarachnoid markings.

The encephalograms revealed evidence of this lesion in one patient who gave a history of having had two severe head injuries, and who also was luetic.

Case VIII. L. F., aged twenty-four, colored male, mechanic, was admitted to the University Hospital January 16, 1931 to the service of Dr. V. A. Dodd.

Chief Complaint. Convulsions.

Family History. Negative.

Past History. He had had smallpox, chicken pox, and measles as a child. He contracted syphilis in 1927.

Present Illness. In 1919, the patient was struck in the upper left occipital region with a ball bat. He was not rendered unconscious by the blow but had bleeding from the mouth and nose. He was able to walk to his home. During the night he became quite restless and complained of generalized headache. The following morning he appeared stuporous and finally became unconscious. He was removed to a hospital where *x*-rays were taken and reported negative for fracture. Numerous lumbar punctures were performed and he was discharged after five months without symptoms.

From this time until 1925 he had only an occasional headache. In 1925 an automobile in which he was riding overturned and he was thrown against the curb. The patient was not rendered unconscious but three weeks later had a convulsion while sleeping. For the next year convulsions occurred about every three months, coming on without the slightest warning and lasting from three to five minutes. During the past eighteen months the attacks had become more frequent and more severe, occurring as often as twice daily. Memory had become defective for recent events.

General physical examination was negative. Blood pressure 117/60.

The *neurological examination* was negative. Eyegrounds and visual fields were normal.

Urine examination and blood count were normal, Wassermann reaction of the blood, 4 plus; spinal fluid Wassermann and colloidal gold reactions negative.

On January 23, 1931 an *encephalography* was performed and the cerebrospinal fluid pressure was found to be 12 mm. Hg. A total of 65 c.c. of fluid was removed and replaced by 60 c.c. of air. The encephalograms revealed the size and number of the subarachnoid pathways to be normal. No localized atrophy was apparent, over the cortex. The lateral ventricles were in the midline but enormously dilated. The third and fourth ventricles were also considerably enlarged.

Diagnosis: Internal hydrocephalus without evidence of cortical atrophy.

COMMENT

Eight patients are presented whose chief complaint upon admission to the hospital was convulsions. The encephalograms revealed a variety of lesions as the probable cause of the convulsive state. We feel that encephalography is an entirely safe procedure, if due regard is paid to the indications for the operation. Pathological lesions responsible for the convulsive state may be disclosed by this method which hitherto could only be demonstrated by operation or at the autopsy table.

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SEX INCIDENCE OF ENTODERMAL TUMORS

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MALIGNANT as well as benign tumors are more frequently found in the digestive tract of the male than they are in the female. Various explanations of this are put forward. One is that the digestive tract of the male is more subject to irritations than is that of the female. One hears quoted, as an example, the frequency of carcinoma of the esophagus in the male Chinese who eats his rice hot, as compared with that in the female Chinese who must wait until her husband has eaten before she partakes, and who thus gets her rice when it has cooled. The fact that gastric cancer is more frequent in males has been explained as due to their swallowing irritating tobacco derivatives. It has been said that lung cancer in males may have its origin in irritation from smoking or inhalation of industrial irritants.

SEX-INCIDENCE OF ENTODERMAL MALFORMATIONS

These conjectures have seemed to me to be materially weakened by the fact that congenital malformations of the digestive tract, where irritation can play no part as the etiological factor, are also more frequent in the male fetus than they are in the female. In investigating a great number of malformations for the purpose of ascertaining whether the first born was more apt to be affected, I collected numerous cases of malformations of the digestive tract, such as atresia of the esophagus, intestine and of the bile ducts; imperforate anus, Meckel's diverticulum, megacolon, absent or malformed bladder, ectopia of the bladder, persistent cloaca, stenosis of the larynx, etc. Of these there were 1051 instances, and in 722 cases, or 68.7 per cent of the total, the baby affected was a male. (Table 1.)

Males have about 55 to 57 per cent of the congenital malformations in general, this figure having been estimated from the Vital Statistics of Canada, for the years 1921 to 1929 inclusive. From the list of 3201 malformations which I had collected, there were 1784 or 55 per cent in the male. The finding of 68.7 per cent of malformations of the digestive tract in the male, therefore, indicates an undue excess of such defects in the male sex. Is it that there is linked with sex some factor for growth of entoderm, which when disturbed causes the defects to be more obvious in one sex than in the other? Sex-linked diseases are by no means uncommon; is it possible that there are sex-linked entodermal malformations?

TABLE 1
CONGENITAL MALFORMATIONS

	Males	*Females*
Imperforate anus	115	60
Atresia of esophagus	56	46
Atresia of intestine	127	108
Atresia of bile ducts	10	2
Bladder, absent or malformed	6	1
Persistent cloaca	2	4
Ectopia vesicae	6	6
Laryngeal stenosis	1	2
Meckel's diverticulum	286	72
Megacolon	113	28
Total	722	329

SEX-INCIDENCE OF ENTODERMAL TUMORS

In the monograph of Pack and LeFevre[2] in which they analysed over 19,000 cases of tumors, they publish a table of the carcinomata that are found in marked excess in one sex or the other, apart from those found in the reproductive organs. It was of interest that so many found in excess in males were of entodermal

origin. It is true that in the column marked "females" there were 4 of the 5 that were also from entoderm. When however, the actual number of the cases of these carcinomata was considered, it was found that the total number was small. (Table II.) Thus carcinomata of the gall bladder, of the urethra, of the appendix and of the thyroid were much more frequent in the female than the male, but the total number of cases of these tumors was small, so that considering entodermal tumors in general, they would form but a small percentage of the whole group.

Table II
TUMORS OF ENTODERMAL ORIGIN

Tumors	Male		Female	
	No. of cases	Average age at which tumor occurred	No. of cases	Average age at which tumor occurred
Carcinoma of tonsil	335	57.1	34	53.2
Epithelioma of pharynx and nasopharynx	65	49.4	21	42.2
Papilloma of larynx	16	34.8	9	37.5
Carcinoma:				
larynx	425	57.3	41	51.7
parotid	29	58.5	16	56.4
esophagus	339	56.7	82	55.9
stomach	231	54.6	103	52.2
colon	60	54.4	47	52.4
rectum	466	63.5	289	51.7
pancreas	15	51	6	45.3
gall bladder	4	57	17	57.8
liver	20	50.2	8	48.2
appendix	2	....	4	
thyroid	37	51.3	118	53.1
urethra	3	45.3	15	56.6
bladder	350	53.6	103	58.9
lung	74	51.8	28	49.5
Adenoma of thyroid	19	41	119	41.8
Papilloma of bladder	44	49.3	22	54
Total	2534	....	1082	
Average age of entodermal tumors	....	56.5	....	51.8

If one selects from the cases reported in this monograph, those that were tumors of entoderm, one gets the list of tumors seen here in Table II. It will be noted that in 14 instances the number of males was greatly in excess of the females. Carcinoma of the prostate was omitted, as were the two tumors of Bartholin's glands, for although the epithelium of these glands is of entodermal origin, the presence of the glands in but one sex would obscure the tendency for tissues that are present in both sexes to be more frequently affected in the male. There were relatively few cases of gall bladder, urethral and appendiceal carcinomata. The tumors of the thyroid were included, although its very close association with the reproductive system of the female would perhaps make for greater involvement in that sex.

In Table II we see that of all tumors derived from entoderm, there were, excluding prostate and Bartholin's glands, a total of 3616. Of these 2534 or 70 per cent occurred in the male. This figure is in very close agreement with the figure, 68.7 per cent, which was found for malformations of the entodermal derivatives in the male. If there is any significance in these figures, and I think that there is, we must be cautious in ascribing the greater frequency of tumors in the male digestive tract and lungs exclusively to greater opportunities for irritation of a physical and chemical nature. On the other hand we would have to recognize with equal certainty, that if there were an underlying hereditary factor making for higher incidence in the male of such tumors, the combination of this with extraneous irritative factors might still further enhance the difference between the two sexes.

Thus if we had 70 males born with potentialities for entodermal tumors to every 30 females with the same capacities, and if $\frac{1}{10}$ of each group died before reaching the tumor age there would be 63 males to every 27 females to develop entodermal tumors. But if, of the 27 who lived to the tumor age, 6 died of some other cause before they had actually developed the tumor itself; while, due to irritations of various natures, the tumor tendency was accelerated in the 63 males so that the tumor started within the ages to which they lived, we would find that the original 70 per cent of males had been raised to 75 per cent. Depending upon the intensity of the irritative factors, and the degree to which they operate to accelerate the growth of the tumor, this original percent-

age might be raised in varying increments.

If this were correct we should expect to find that the average age of onset of the tumor was earlier in the male than in the female. For this purpose I computed the average age at which the tumor developed in Pack and LeFevre's series of cases, using the midpoint of each age period as the average age for that group. For example, those grouped from forty to forty-four were taken as aged forty-two. The results of this are shown in Table II. It will be noted that the average age of tumor formation in the male is over four years higher than is the average for the female, and in 11 of the 19 tumors in the list, the average age of onset was higher in the male than in the female. This would seem to cast doubt upon the interpretation that the higher incidence in the male sex of entodermal tumors was accentuated by the fact that the male entodermal tract is exposed to more irritants than are the female entodermal derivatives. Pack found that in all tumors the average age of onset in the female was from two and one-half to four years earlier than the onset of similar tumors in the male.

SEX-LINKAGE OF FACTORS FOR TUMORS IN ENTODERM

If the male tends uniformly to show a higher percentage of entodermal tumors and entodermal malformations than does the female, is the factor or group of factors concerned in the production of these developmental defects located in part or in whole in the sex chromosome? If so, how do the factors operate to produce this greater number of males? It is probable that if the factors are inherited, and if some of them are present in the sex chromosome, then one of the factors is probably recessive in nature, this being the combination that yields a higher percentage of males. We might conceive of this combination as being a pair of unit recessive factors located in the sex chromosome, in which case the combinations possible are shown in Table III.

It will be noted that Matings 3, 4, 5, and 6 all give defective offspring, these being shown by RR, a defective female, and R, a defective male. If all types of matings were made equally frequently, and if there were in the aggregate the same number of children to each mating, than there would be 66.6 per cent males and 33.3 per cent females affected. This figure, it is true, agrees closely with the percentage of affected males found in the malformation and the tumor group. On the other hand, most of the malformations are such that it can be definitely said that neither parent had them, and so the offspring of matings 4, 5, and 6 must be discarded. In this event we find that 100 per cent of those affected would be males; yet we remember there were actually 31.3 per cent females with entodermal defects.

TABLE III

POSSIBLE MATINGS TO SHOW TRANSMISSION OF SEX-LINKED RECESSIVE FACTOR

1. DD × D = DD + D
2. DD × R = DR + D
3. DR × D = DD + DR + D + R
4. DR × R = DR + RR + D + R
5. RR × D = DR + R
6. RR × R = RR + R

If we study Table IV, and consider that the defect is due to a pair of recessive factors in the autosomes and a recessive in the sex chromosome, then the affected persons are represented by $\frac{RR}{RR}$ for an affected female and $\frac{RR}{R}$ for an affected male. If all matings are made with the same frequency, 66.6 per cent of those affected would be males, if all matings are considered; 68.8 per cent if only one or neither parent was affected; and 76 per cent males affected if neither parent was affected. If we consider that the defect is due to a dominant factor in the autosomes and a recessive in the sex chromosomes, then the constitution of the affected females would be either $\frac{DD}{RR}$ or $\frac{DR}{RR}$, and of the affected males $\frac{DD}{R}$ or $\frac{DR}{R}$ The percentages then of affected would

Table IV

1. $\frac{DD}{RR} \times \frac{DD}{R} = \frac{DD}{RR} + \frac{DD}{R}$
2. $\frac{DD}{RR} \times \frac{DD}{D} = \frac{DD}{DR} + \frac{DD}{R}$
3. $\frac{DD}{RR} \times \frac{DR}{R} = \frac{DD}{RR} + \frac{DD}{R} + \frac{DR}{RR} + \frac{DR}{R}$
4. $\frac{DD}{RR} \times \frac{DR}{D} = \frac{DD}{DR} + \frac{DD}{R} + \frac{DR}{DR} + \frac{DR}{R}$
5. $\frac{DD}{RR} \times \frac{RR}{R} = \frac{DR}{RR} + \frac{DR}{R}$
6. $\frac{DD}{RR} \times \frac{RR}{D} = \frac{DR}{DR} + \frac{DR}{R}$
7. $\frac{DD}{DR} \times \frac{DD}{R} = \frac{DD}{RR} + \frac{DD}{DR} + \frac{DD}{D} + \frac{DD}{R}$
8. $\frac{DD}{DR} \times \frac{DD}{D} = \frac{DD}{DD} + \frac{DD}{DR} + \frac{DD}{D} + \frac{DD}{R}$
9. $\frac{DD}{DR} \times \frac{DR}{R} = \frac{DD}{DR} + \frac{DD}{RR} + \frac{DR}{DR} + \frac{DR}{RR} + \frac{DD}{D} + \frac{DD}{R} + \frac{DR}{D} + \frac{DR}{R}$
10. $\frac{DD}{DR} \times \frac{DR}{D} = \frac{DD}{DD} + \frac{DD}{DR} + \frac{DR}{DD} + \frac{DR}{DR} + \frac{DD}{D} + \frac{DD}{R} + \frac{DR}{D} + \frac{DR}{R}$
11. $\frac{DD}{DR} \times \frac{R}{R} = \frac{DR}{DR} + \frac{DR}{RR} + \frac{DR}{D} + \frac{DR}{R}$
12. $\frac{DD}{DR} \times \frac{RR}{D} = \frac{DR}{DD} + \frac{DR}{DR} + \frac{DR}{D} + \frac{DR}{R}$
13. $\frac{DD}{DD} \times \frac{DD}{R} = \frac{DD}{DR} + \frac{DD}{D}$
14. $\frac{DD}{DD} \times \frac{DD}{D} = \frac{DD}{DD} + \frac{DD}{D}$
15. $\frac{DD}{DD} \times \frac{DR}{R} = \frac{DD}{DR} + \frac{DR}{DR} + \frac{DD}{D} + \frac{DR}{D}$
16. $\frac{DD}{DD} \times \frac{DR}{D} = \frac{DR}{DD} + \frac{DD}{DD} + \frac{DD}{D} + \frac{DR}{D}$
17. $\frac{DD}{DD} \times \frac{RR}{R} = \frac{DR}{DR} + \frac{DR}{D}$
18. $\frac{DD}{DD} \times \frac{RR}{D} = \frac{DR}{DD} + \frac{DR}{D}$
19. $\frac{RR}{RR} \times \frac{DD}{R} = \frac{DR}{RR} + \frac{DR}{R}$
20. $\frac{RR}{RR} \times \frac{DD}{D} = \frac{DR}{DR} + \frac{DR}{R}$
21. $\frac{RR}{RR} \times \frac{DR}{R} = \frac{DR}{RR} + \frac{RR}{RR} + \frac{DR}{R} + \frac{RR}{R}$
22. $\frac{RR}{RR} \times \frac{DR}{D} = \frac{DR}{DR} + \frac{RR}{DR} + \frac{DR}{R} + \frac{RR}{R}$
23. $\frac{RR}{RR} \times \frac{RR}{R} = \frac{RR}{RR} + \frac{RR}{R}$
24. $\frac{RR}{RR} \times \frac{RR}{D} = \frac{RR}{DR} + \frac{RR}{R}$
25. $\frac{RR}{DR} \times \frac{DD}{R} = \frac{DR}{DR} + \frac{DR}{RR} + \frac{DR}{D} + \frac{DR}{R}$
26. $\frac{RR}{DR} \times \frac{DD}{D} = \frac{DR}{DD} + \frac{DR}{DR} + \frac{DR}{D} + \frac{DR}{R}$
27. $\frac{RR}{DR} \times \frac{DR}{R} = \frac{DR}{DR} + \frac{DR}{RR} + \frac{RR}{DR} + \frac{RR}{RR} + \frac{DR}{D} + \frac{DR}{R} + \frac{RR}{D} + \frac{RR}{R}$

TABLE IV (*Continued*)

28. $\frac{RR}{DR} \times \frac{DR}{D} = \frac{DR}{DD} + \frac{DR}{DR} + \frac{DR}{D} + \frac{DR}{R} + \frac{RR}{DD} + \frac{RR}{DR} + \frac{RR}{D} + \frac{RR}{R}$

29. $\frac{RR}{DR} \times \frac{RR}{R} = \frac{RR}{DR} + \frac{RR}{RR} + \frac{RR}{D} + \frac{RR}{R}$

30. $\frac{RR}{DR} \times \frac{RR}{D} = \frac{RR}{DD} + \frac{RR}{DR} + \frac{RR}{D} + \frac{RR}{R}$

31. $\frac{RR}{DD} \times \frac{DD}{R} = \frac{DR}{DR} + \frac{DR}{D}$

32. $\frac{RR}{DD} \times \frac{DD}{D} = \frac{DR}{DD} + \frac{DR}{D}$

33. $\frac{RR}{DD} \times \frac{DR}{R} = \frac{DR}{DR} + \frac{DR}{D} + \frac{RR}{DR} + \frac{RR}{D}$

34. $\frac{RR}{DD} \times \frac{DR}{D} = \frac{DR}{DD} + \frac{RR}{DD} + \frac{DR}{D} + \frac{RR}{D}$

35. $\frac{RR}{DD} \times \frac{RR}{R} = \frac{RR}{DR} + \frac{RR}{D}$

36. $\frac{RR}{DD} \times \frac{RR}{D} = \frac{RR}{DD} + \frac{RR}{D}$

37. $\frac{DR}{RR} \times \frac{DD}{R} = \frac{DD}{RR} + \frac{DR}{RR} + \frac{DD}{R} + \frac{DR}{R}$

38. $\frac{DR}{RR} \times \frac{DD}{D} = \frac{DD}{DR} + \frac{DR}{DR} + \frac{DD}{R} + \frac{DR}{R}$

39. $\frac{DR}{RR} \times \frac{DR}{R} = \frac{DD}{RR} + \frac{DD}{R} + {}_2\frac{DR}{RR} + {}_2\frac{DR}{R} + \frac{RR}{RR} + \frac{RR}{R}$

40. $\frac{DR}{RR} \times \frac{DR}{D} = \frac{DD}{DR} + \frac{DD}{R} + {}_2\frac{DR}{DR} + {}_2\frac{DR}{R} + \frac{RR}{DR} + \frac{RR}{R}$

41. $\frac{DR}{RR} \times \frac{RR}{R} = \frac{DR}{RR} + \frac{DR}{R} + \frac{RR}{RR} + \frac{RR}{R}$

42. $\frac{DR}{RR} \times \frac{RR}{D} = \frac{DR}{DR} + \frac{DR}{R} + \frac{RR}{DR} + \frac{RR}{R}$

43. $\frac{DR}{DR} \times \frac{DD}{R} = \frac{DR}{DR} + \frac{DR}{RR} + \frac{DD}{DR} + \frac{DD}{RR} + {}_2\frac{DD}{D} + {}_2\frac{DR}{R}$

44. $\frac{DR}{DR} \times \frac{DD}{D} = \frac{DD}{DD} + \frac{DR}{DD} + \frac{DD}{DR} + \frac{DR}{DR} + \frac{DD}{D} + \frac{DR}{D} + \frac{DD}{R} + \frac{DR}{R}$

45. $\frac{DR}{DR} \times \frac{DR}{R} = \frac{DD}{DR} + \frac{DD}{RR} + \frac{DD}{D} + \frac{DD}{R} + \frac{RR}{DR} + \frac{RR}{RR} + \frac{RR}{D} + \frac{RR}{R} + {}_2\frac{DR}{DR} + {}_2\frac{DR}{RR} + {}_2\frac{DR}{D} + {}_2\frac{DR}{R}$

46. $\frac{DR}{DR} \times \frac{DR}{D} = \frac{DD}{DD} + \frac{DD}{DR} + \frac{DD}{D} + \frac{DD}{R} + \frac{RR}{DD} + \frac{RR}{DR} + \frac{RR}{D} + \frac{RR}{R} + {}_2\frac{DR}{DD} + {}_2\frac{DR}{DR} + {}_2\frac{DR}{D} + {}_2\frac{DR}{R}$

47. $\frac{DR}{DR} \times \frac{RR}{R} = \frac{DR}{DR} + \frac{DR}{RR} + \frac{RR}{DR} + \frac{RR}{RR} + \frac{DR}{D} + \frac{DR}{R} + \frac{RR}{D} + \frac{RR}{R}$

48. $\frac{DR}{DR} \times \frac{RR}{D} = \frac{DR}{DD} + \frac{DR}{DR} + \frac{RR}{DD} + \frac{RR}{DR} + \frac{DR}{D} + \frac{DR}{R} + \frac{RR}{D} + \frac{RR}{R}$

49. $\frac{DR}{DD} \times \frac{DD}{R} = \frac{DD}{DR} + \frac{DR}{DR} + \frac{DD}{D} + \frac{DR}{D}$

50. $\frac{DR}{DD} \times \frac{DD}{D} = \frac{DD}{DD} + \frac{DR}{DD} + \frac{DD}{D} + \frac{DR}{D}$

51. $\frac{DR}{DD} \times \frac{DR}{R} = \frac{DD}{DR} + \frac{DD}{D} + \frac{RR}{DR} + \frac{RR}{D} + {}_2\frac{DR}{DR} + {}_2\frac{DR}{D}$

52. $\frac{DR}{DD} \times \frac{DR}{D} = \frac{DD}{DD} + \frac{DD}{D} + \frac{RR}{DD} + \frac{RR}{D} + {}_2\frac{DR}{DD} + {}_2\frac{DR}{D}$

53. $\frac{DR}{DD} \times \frac{RR}{R} = \frac{DR}{DR} + \frac{RR}{DR} + \frac{DR}{D} + \frac{RR}{D}$

54. $\frac{DR}{DD} \times \frac{RR}{D} = \frac{DR}{DD} + \frac{RR}{DD} + \frac{DR}{D} + \frac{RR}{D}$

be, males, 66.6 if all matings were considered, 72 per cent if only one parent or no parents were affected, and 88 per cent if just those matings were considered in which neither parent was affected.

From these percentages we can at once exclude the first possibility, namely, that entodermal malformations, at least, are due to a pair of recessive factors located in the sex chromosome, for as stated above, many of them are of such nature that if present in the parents they would have been noted, and if not present in either parent, the affected persons would all have to be males, while in reality there were 31.7 per cent affected females.

This theory also is difficult of application in the case of entodermal tumors. Table III shows that no female can have a sex-linked recessive character, unless her father had the outspoken character itself, and the mother was at least a carrier of the defect. Now it is quite certain that tumors of entodermal origin occur in many women whose parents lived sufficiently long to establish with a fair degree of certitude that neither of them had any entodermal tumors. The second and third theories, namely that the entodermal defects are due to two sets of factors, one carried in the sex chromosome, and recessive in nature, the other in a pair of autosomes, and either recessive or dominant in character, are more fitting, for here one sees that it is possible for the female to be affected when neither parent is affected. Thus in matings 27, 39 and 45, in Table IV the combination $\frac{RR}{RR}$ designating an affected female according to theory 2, is found when the two parents are normal. If theory 3 be accepted then matings 11 and 47 show affected daughters, $\frac{DR}{RR}$, when neither parent had a tumor. Both theories seem applicable from the standpoint of percentage of affected males, the one ranging from 66.6 to 76, the other from 66.6 to 88, as one considers all matings, those in which only one or no parent was affected and those in which neither parent was affected.

Other interesting facts are brought out by an analysis of Table IV. Thus if we consider one of these factors to be dominant, the other recessive, we note that in three matings, Nos. 1, 3 and 37, if both parents have the same type of entodermal tumor, all children are affected, but in mating 39, although both parents are affected there are some sons and daughters who are incapable of developing the tumor.

Again in six matings, Nos. 13, 15, 31, 33, 49, 51, although the father was affected, none of the children has inherited the proper combination for the tumor, and is incapable of showing it. In matings 7, 9, 19, 21, 25, 27, 43, 45, the father is affected, $\frac{DR}{R}$ or $\frac{DD}{R}$, and both sons and daughters show the tumor.

There are no matings in which the mother is affected, and it is impossible for the children to be affected, all such matings showing a possibility of sons at least developing the tumor. Thus in matings 2, 4, 6, 38, 40, 42, there is a possibility of the affected mother having affected sons, $\frac{DR}{R}$ or $\frac{DD}{R}$.

In a few cases, if the mother only is affected, both sons and daughters may be affected. This is true in matings 5 and 41.

If both parents are free, there are numerous matings which produce affected children, some of them showing only sons affected, others yielding both affected sons and daughters. Thus, matings 8, 10, 12, 20, 22, 26, 28, 44, 46, 48, show only sons with the combination necessary for tumors, while matings 11 and 47 can produce both girls and boys with the factors essential for tumor formation.

It must be remembered that these represent only possibilities. It is quite possible for a mother to have entodermal tumors, and have no children who develop them. The possibility remains, however, that on the basis of this theory she might have had affected offspring.

If the theory that both factors be

recessive be considered one finds that if both parents are affected, then all children will be affected (mating 23). If neither parent is affected, both sons and daughters may develop the tumors in matings 27, 39, 45; while sons only will be affected in matings 28, 30, 40, 42, 46, and 48. If the mother alone is affected, mating 21 shows both sons and daughters capable of developing the tumor, sons only affected in 22 and 24, and neither affected in 19 and 20. If the father alone is affected matings 29, 41 and 47 yield both sons and daughters affected; while matings 5, 11, 17, 35 and 53 show that there is no possibility for children to be affected although the father had the tumor.

In either event, one notices that there are matings which permit sons to be affected, when daughters must be normal. This provides for the higher incidence of such tumors among males. It might well be that different entodermal tumors depend upon different combinations, thus accounting for the frequency or the rarity of the tumor in the population. Thus carcinoma of the rectum, which is quite common, might depend upon the combination $\frac{DD}{RR}, \frac{DR}{RR}, \frac{DD}{R}$ or $\frac{DR}{R}$. Carcinoma of the lung, on the other hand, might be due to two sets of recessives, such as $\frac{RR}{RR}$ and $\frac{RR}{R}$. The chances for the combination responsible for carcinoma of the rectum being made would be very much higher than would be the chances for the combination responsible for carcinoma of the lung. Both, however, would show about the same sex incidence, namely from 66 to about 75 per cent of the tumors being in the male.

It might be objected here that tumors not entodermal in origin show a higher incidence in the male in many cases, and that these appear undoubtedly to be due to irritation, and that if this is so, why postulate a sex-linked factor for entodermal tumors? Thus carcinoma of the lip, of the floor of the mouth, of the tongue, of the buccal mucosa and of the superior maxilla and inferior alveolus are more frequent in the male. If one examines Pack's series in which he says that the sex distribution of the various tumors is about the same as that found in the population of tumor cases everywhere, one finds that of all tumors apart from those of the reproductive system in the two sexes and of the breast in the female, there were 67.4 per cent in males, 32.6 per cent in females. This too agrees very closely with the expected percentage if all tumors had a recessive sex-linked factor in addition to other factors located in the autosomes. The excessive predominance of lip and mouth or laryngeal cancer in the male might well be due to irritative factors which are more frequent in the male superimposed upon an inherited basis, which had already destined more males than females to be affected. As the injury to the tissue developing the tumor became more nearly equal in quantity in the two sexes the more nearly would the ratio approach to the 2.1 ratio mentioned.

Although the occurrence of sex-linked entodermal tumors of a malignant nature in forms other than man would not be any proof that such tumors occurred in the human being, such sex-linkage would at least show that tumors were so inherited, and remove some of the scepticism concerning such a mode of inheritance. Stark has described sex-linked entodermal tumors in the larval stage of Drosophila, which are unit sex-linked recessive characters killing one quarter of the larvae, those dying being males. The character is transmitted through the unaffected mother. In man, it may well be that one of the factors for entodermal tumor growth is sex-linked and recessive; it may even be that one of the factors for all tumor growth is located in the sex chromosome. Inasmuch as the most frequent tumor investigated experimentally in animals is the mammary gland tumor, which is of necessity limited to the female, this sex-incidence, if it occurs in animals also, has been overlooked.

In a recent paper given before the Sixth International Congress of Genetics,

Holmes pointed out that congenital malformations were more common in the male, and that the male was more susceptible to infectious diseases of childhood, etc. He objected to the interpretation that sex-linkage had anything to do with these, but attributed them all to the general organization of the male, which was less adapted to the environment, or which, because of its own structural peculiarities, was more apt to develop malformations. He brought out the fact that inguinal hernia was far more frequent in the male sex than in the female. It was not due to sex linkage, but to the peculiar structure of the inguinal canal in the male, that this condition showed such a high incidence in the male sex.

This objection does not seem to me to be conclusive, for if we eliminate those malformations or diseases which are due to structural differences between the sexes, and consider only those organs such as liver, intestine, etc. which are alike in the two sexes, it becomes difficult to postulate a difference in general organization that enables the male to show anomalies of structure more often than does the female, unless one concludes that the constitutional inferiority which Holmes says is characteristic of the male is dependent upon hormones from the gonadal tissue. In this connection it might be of interest to see if lung tumors or gastro-intestinal tumors developed any less frequently in castrated animals in the laboratory than did their non-castrated litter mates. Naturally tumors developing in gonadal or breast tissues would have to be eliminated from consideration.

SUMMARY

In view of the fact that entodermal tumors occur on the whole about twice as frequently in the male as in the female, and in view of the similar ratio found in entodermal malformations, it is open to question whether the greater incidence in the male is due wholly to opportunities for greater irritation in that sex. It is postulated that some inherent quality in the male is responsible for this greater occurrence of entodermal malformations. Inasmuch as the ratio of two affected males to one affected female would be expected, if one of the factors necessary for the tumors or the malformations were a recessive and located in the sex chromosome, and if all the possible matings were made with about the same frequency, it has been suggested that the high sex incidence of entodermal tumors and malformations may be explained by the fact that one factor for these defects is recessive and located in the sex chromosome.

If only those tumors originating in tissues common to the two sexes be considered, it is found that tumors are twice as frequent in males as in females. This suggests that the basis for all tumor growth may be recessive and sex-linked, the other factors determining site and type of growth being of varied character and located in the autosomes.

Chronic irritation may enhance the incidence of certain tumors in the male sex; thus carcinoma of the lip, mouth, larynx, in which the ratio of males to females may be much greater than 2.1, may be stimulated in many hereditarily susceptible males in whom the hereditary factors would not have been evident without the irritation of smoking, etc. The same hereditary factors, lying latent in the female and not being evoked by the irritation, would remain unexpressed. This would upset the normal 2:1 ratio. Chronic irritation cannot be accepted as the universal explanation of the high male incidence for it is found in sites in which chronic irritation cannot be proved.

Hence the explanation of this increased incidence in the male appears to rest upon factors inherent in the male constitution; factors which are genetic in their basis, and not merely dependent upon hormonal influences arising from male gonadal tissue.

[For References see p. 457.]

CHRONIC THYROID DISEASE
ONE CONTINUOUS DISEASE PROCESS

A DIAGRAMMATIC AND SIMPLE REVIEW OF ITS EVOLUTION AS PROPOSED BY HERTZLER*

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THE purpose of this essay is to expedite, in a diagrammatic and simple review, a better and further understanding of the evolution of chronic thyroid disease as one continuous disease process as proposed by Hertzler[1] in order that it may no longer be necessary to be burdened and confused with the existing classifications of thyroid disease. And furthermore, now that Rienhoff[2] has recently verified experimentally the masterful clinical investigations from which Hertzler drew his conclusions, goitrous disease should be recognized and taught as one continuous disease process.

Whereas heretofore thyroid disease had been classified into distinct clinical entities, it remained for Hertzler to demonstrate that such is not the case but that these so-called clinical entities are nothing more than progressive pathological stages of one continuous disease process extending over a period of years as a result of some obnoxious substance circulating in the blood stream. The thyroid gland as a result of this obnoxious substance is called upon to do its duty and responds with a compensatory hypertrophy and hyperplasia which, as time goes on, progresses through a series of aggressive and regressive changes which reflect themselves pathologically into the following stages:

1. Uniform stage (*simple colloid goiter*)
2. Bossilated stage (*non-toxic adenoma*)
3. Chronic toxic stage (*toxic adenoma*)

and

4. Acute toxic stage (*exophthalmic goiter*).

Inasmuch as no gland functions biologically in its entirity, the histopathological picture of the physiological response of the thyroid gland to the increased demand for function is directly proportional to (1) the duration of the demand, and (2) the functional capacity of the units called upon. These units, which are ever so small, are intralobular and scattered throughout the entire gland. Within the clinical course of the disease the earliest maximum functional response is seen as the uniform stage and the final maximum functional response as the acute toxic stage. Intermediary responses are seen as the bossilated and chronic toxic stages, respectively. The functional capacity of any unit lasts only so long before it is terminated in either one of two ways, namely by (1) involution as a physiological process, or (2) remission of the disease process. As its functional capacity fades out the unit is replaced by either another that is quiescent and becomes active, or a somewhat lesser active unit which takes on further activity. Such physiological and pathological facts explain why there is never seen any sharp line of demarcation between the different stages. Regression of any functionally active unit never goes beyond the uniform stage. One stage usually fades into the other. It is not uncommon in the acute toxic stage to see a single microscopic field run the gamut of

[1] Hertzler, A. E. Pathenogenesis of goiter considered as one continuous disease process. *Arch. Surg.*, 16: 61–78, 1928.

[2] Rienhoff, W. F., Jr. Involutional or regressive changes in the thyroid gland in cases of exophthalmic goiter and their relation to the origin of the so-called adenomas. *Arch. Surg.*, 13: 391, 1926.

* From the Goiter Clinic and Department of Surgery, Northwestern University Medical School, Chicago. The purpose of this essay and its contents have met with the approval of my former surgical preceptor, Dr. Arthur E. Hertzler.

all four stages. Nevertheless for a better and more simple understanding the different stages are considered as separate and exophthalmic goiter develops and progresses through the four stages so rapidly that within its usual clinical onset of eight

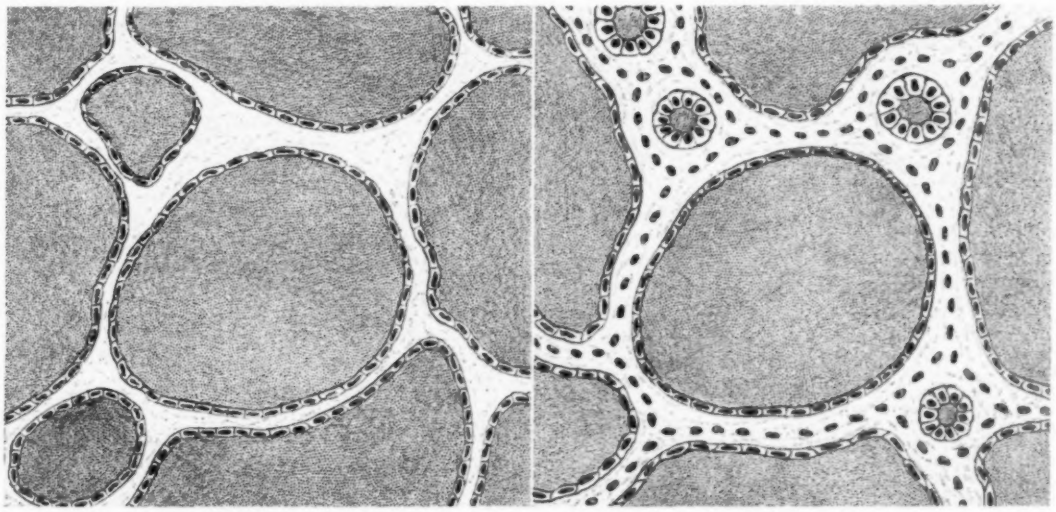

Fig. 1A. Fig. 1B.

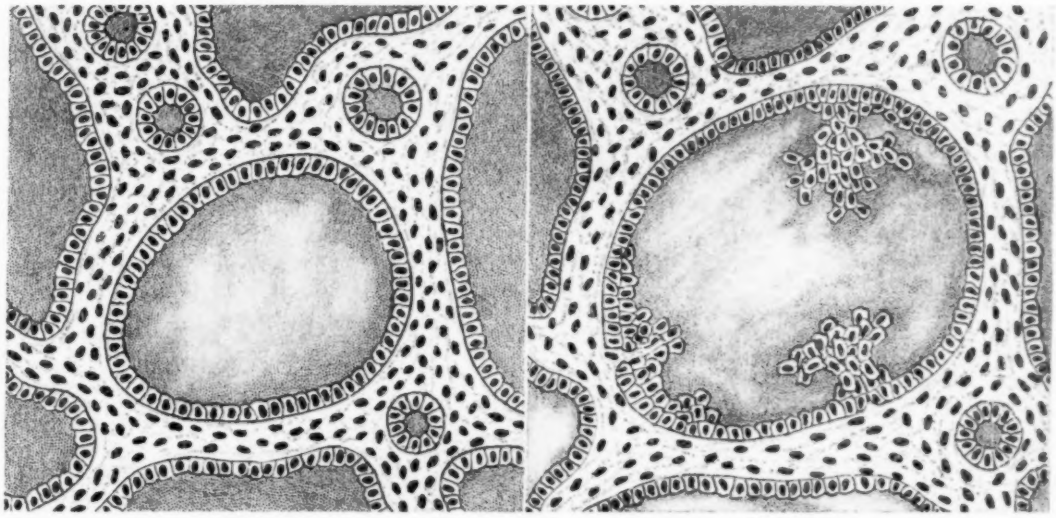

Fig. 1C. Fig. 1D.

Fig. 1. A. Uniform stage. B. Bossilated stage. C. Chronic toxic stage. D. Acute toxic stage.

distinct units.

The acute primary exophthalmic goiter and the diffuse hyperplastic, non-toxic adenomatous, toxic adenomatous and acute secondary exophthalmic goiters which make up the chronic variety, all progress through the same successive pathological stages. The only difference between them is their gross appearance and the frequency with which secondary degenerative changes occur. The latter difference is governed by the element of time. The acute primary months or so there is not sufficient time for the development of bossilation (nodulation). If the diffuse hyperplastic goiter with toxicity were to run a clinical course similar to and as long as does the bossilated types, bossilation would result. The longer the disease process continues the more frequent secondary changes are seen and the more frequent bossilation occurs.

Nothing is said about vascular changes for they are most deceiving. What may seem to be comparatively a not very

vascular thyroid gland in the laboratory may be just the opposite in the operating room and cause the surgeon considerable difficulty in completing hemostasis.

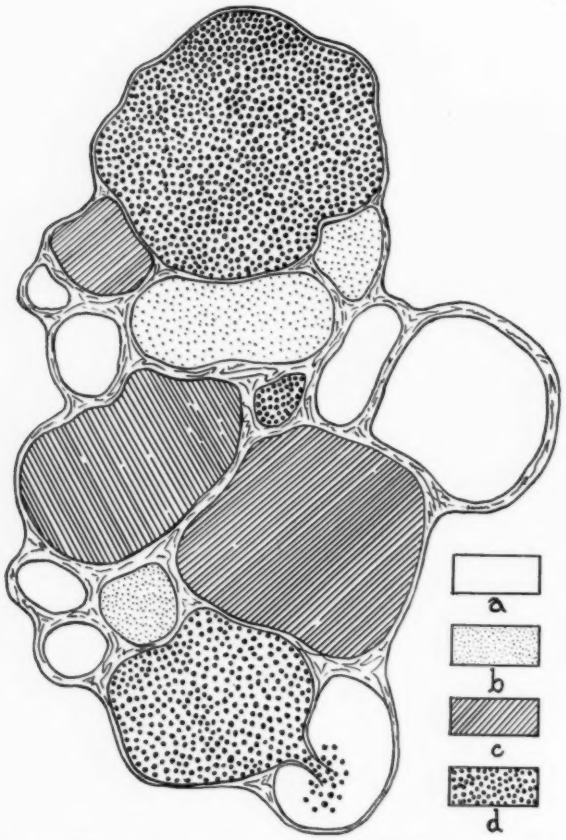

Fig. 2. Gross cross section of thyroid gland in acute toxic stage. A. Uniform stage. B. Bossilated stage. C. Chronic toxic stage. D. Acute toxic stage.

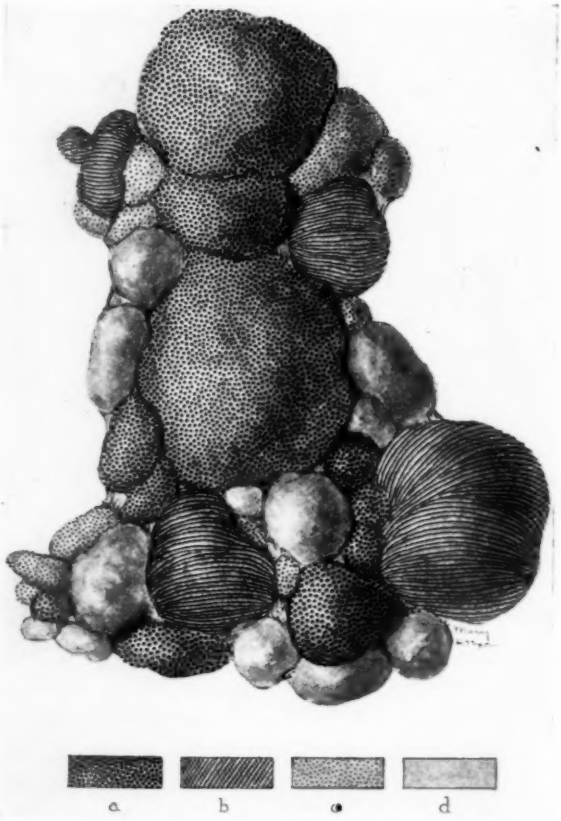

Fig. 3. Gross appearance of bossilation as seen in acute toxic stage. A. Acute toxic stage. B. Chronic toxic stage. C. Bossilated stage. D. Uniform stage.

Figure 2 with its cross-etching effect represents diagrammatically the microscopical stages which predominate within the respective lobules. Associated with that stage which predominates is always found one or more of the others depending upon the stage of development reached by the disease process.

The lobule with its agglomerate masses of smaller lobuli and their functioning units is the fundamental structure of bossilation (nodulation). As the general hypertrophy and hyperplasia progresses, the intralobular pressure increases in direct proportion to the amount of cellular proliferation; hence the size of the lobule is determined. The acute toxic stage usually represents the maximum of cellular proliferation. The extralobular connective tissue septa are thinned out with the increase of pressure within the lobules and their relative thickness is directly proportional to the increased cellular content within the lobules which they surround. At times the septa are so thinned out that the increase of pressure ruptures them and then the lobule under greatest tension expands into its neighbor to form a larger lobule. Hence the origin of many of the larger bossilations. Should this rupture involve and tear a small blood vessel, hemorrhage followed later by degenerative cystic changes results within the lobule.

Figure 3 demonstrates gross bossilation of the thyroid gland in the terminal

or acute toxic stage. The aggressive and regressive internal turmoil within the entire gland that causes lobulation to vary in size and tension is manifested in the gross specimen as bossilation. The firmness in consistency of any bossilation is directly proportional to the degree of cellular proliferation but, unlike carcinoma in general which is likewise a process of cellular proliferation, it never approaches actual hardness unless either malignancy or inflammation is present. Hemorrhage will also often cause bossilation to be actually hard to the touch. Involution on the contrary often, if of sufficient magnitude, softens to a considerable extent bossilation that was at one time very firm. It can be said in general that actual firmness (rubber-ball consistency) of the thyroid gland bespeaks toxicity, but the converse is not always true. Very toxic symptoms may occasionally be present where it is either impossible to feel any goiter or, if the goiter is palpable, it is soft and elastic to the touch. Fortunately such represents only a bare minority of cases. Too often indeed, after the surgeon operates, he finds out how deceiving are the physical findings in this group of cases.

Goitrous diseases should be recognized and taught as one continuous disease process as proposed by Hertzler.

A. The uniform stage is characterized by acini that are filled with homogeneous and eosinophilic staining colloid material. The acinar cells are of the flat epithelial variety. The interstitium, except for connective tissue cells, contains relatively few if any cellular elements or newly formed acini and for this reason are omitted from the diagram.

B. The bossilated stage is the next progressive step in the response of the thyroid gland to the increase in demand for its function. The uniform stage plus a *one plus* compensatory hypertrophy of Greenfield[3] makes up the histopathological picture. This compensatory hypertrophy is physiological and its microscopical manifestation is nothing more than the appearance within the interstitium of newly formed acini and interstitial cells which are often called fetal cells. The nuclei of the latter cells, morphologically and in staining quality, are similar to those of the cells lining the original and newly formed acini. They stain basophilic.

C. The chronic toxic stage is next approached and is heralded with the addition to the bossilated stage of a hypertrophy of the cells lining the original acini to the cuboidal or low columnar type and an increase in the interstitial elements to a *two plus* hyperplasia in which the cellular element far exceeds the newly formed acini.

D. The acute toxic stage brings to a climax the hyperplasia within the interstitium. It adds to the chronic toxic stage an increased hypertrophy of the original acinar cells to a high columnar type and also a hyperplasia of these cells. Papillary pegs of hyperplastic columnar cells project into the acinar cavities. Such pegs are pathognomonic of this stage. The interstitial hyperplasia reaches the symbolic degree of *three plus*. The colloid in many areas becomes liquefactive and takes little or no stain.

[3] Greenfield, W. S. Bradshaw lectures. *Brit. M. J.*, 2: 1261, 1893.

PHYSIOLOGIC ARTIFICIAL INSEMINATION*

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NEW YORK CITY

AN interesting practical application of the biochemical studies of prostatovesicular secretions relative to the metabolism and viability of spermatozoa is the problem of the transposition of spermatozoa from the normal to the azoospermic vesicle.

In some instances of azoospermia or absence of spermatozoa in the semen, it has been recommended to obtain the semen from some individual other than the husband, insemination being accomplished by injecting the seminal fluid into the cervix. It has been stated that only an intense desire for progeny on the part of the female and complaisance on the part of the husband justifies this procedure. The knowledge of the fact that the material is obtained from an alien or heterogeneous source is likely to prove disquieting to the sensitive female, to say nothing of the unphysiological nature of the process.

Both of these objections can be overcome by the following simple method of artificial fertilization or impregnation, which procedure we believe to be not only practical, but obviously advantageous in certain cases.

Through a cystourethroscope such as the McCarthy foroblique panendoscope with its special ejaculatory duct attachment, the ejaculatory ducts are catheterized with small flexible No. 3 or 4 catheters, by the method which Dr. Joseph F. McCarthy and Dr. J. S. Ritter have advocated. The semen from a normal healthy individual, which obviously is easily obtained, preferably from a blood relative of the husband who has submitted to a complete physical examination to determine his desirability as a donor, is injected into the seminal vesicle with a syringe, in precisely the same way in which sodium iodide solutions are used in obtaining seminal vesiculograms or as the colloid preparations of silver are used in the treatment of vesicular infections.

The semen is collected under careful aseptic precautions and is incubated aseptically at body temperature with a nutrient medium, such as a 4.5 per cent solution of glucose buffered with phosphate to a hydrogen ion concentration of 7.6, which solution has been developed in previous experimental work at the Biochemistry Laboratories of the New York Post Graduate Medical School and Hospital, under the direction of John A. Killian.

This mixture assures a solution, the viscosity of which is such as to readily permit injection through a small ejaculatory duct catheter with a syringe. The solution also affords a suitable medium for activation of sluggishly motile spermatozoa, of which phenomenon we have made photographic records on a motion picture film.

Coitus may be performed immediately or within a reasonable period after insemination, the act not being interfered with by the slight trauma or disturbance of the tissue incidental to the instrumentation.

We believe that by this method, the opportunity for impregnation is afforded in a perfectly natural and physiologic manner, free from aesthetic objection on the part of the female.

In following the foregoing plan, the source of the spermatozoa may be revealed or not, at the discretion of the husband, although in the studies of our cases, the written consent of both husband and wife has always been obtained.

As concerns the female, the question arises as to what day or days in the intermenstrual period shall we select for

* Presented at the Section of Genito-Urinary Surgery, N. Y. Academy of Medicine, Nov. 18, 1931.

coitus in order to render conception most probable. According to the present status of our knowledge, women are more fecund from the ninth to the seventeenth day after menstruation starts. The most favorable day for a single injection is approximately the thirteenth of the menstrual cycle, counting from the first day of the previous menstruation.

Repeated inseminations may be indicated, Nürnberger concluding that it should be done three times in the intermenstrual cycle.

While we have performed few experiments as yet, I am of the opinion that granting a comparative freedom of the vesicle from infection, spermatozoa from an alien source will probably thrive quite as well in the vesicle of the recipient as in that of the donor. The injected spermatozoa are not so "alien" to their new habitat, as spermatozoa always are to the generative tract of the female.

It is obvious and evident that this method of artificial insemination would be indicated only in selected cases. In instances in which the seminal vesicles of the husband are seriously diseased, the method could not be used successfully. When the sterility of the male is associated with sufficiently abnormal vaginal secretions to destroy the spermatozoa, the method would not be useful. In cases in which not only is the husband sterile, but also mechanical obstructions exist in the wife's cervical canal, the method could be supplemented by obtaining the semen from the vagina after coitus and injecting it into the uterus.

Our object in presenting this report and making this preliminary note is merely to place it on record pending such opportunities as my present themselves to put it into actual practice.

Experiments to determine the feasibility of the method so far as concerns the conveyance of the spermatozoa during coitus are very easily accomplished by examinations for motility of spermatozoa in condom specimens of semen at stated intervals following insemination. In a number of our studied cases this motility was noted twenty-four hours, and in one case forty-eight hours after this method of physiologic fertilization had been accomplished.

There is a record of a previous report concerning this procedure in which an operative approach was utilized. It was advocated that a small incision be made on either side of the scrotum, exposing the vas, as in vasostomy. The injection of the vas with normal, but undiluted semen, follows, granting however a patent vas on the proximal side of the point of injection. No instances of successful insemination by this method have been reported.

We believe that our method is very likely to prove feasible in selected cases of azoospermia and we feel that it offers a fertile field for further investigation. However, we would emphasize that the entire question is still in the field of experimental study.

Grateful acknowledgment is made for the stimulus and many valuable suggestions in these studies to Dr. Joseph F. McCarthy, Director of the Department of Urology, New York Post Graduate Medical School and Hospital of Columbia University, to whom credit for this work should be largely ascribed.

CASE REPORTS

NEEDLES IN THE DEEP URETHRA; STONE AND PERIURETHRAL ABSCESS

CASE REPORT IN SEVEN-YEAR-OLD BOY*

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NEW YORK CITY

MASTURBATION in children by the introduction of foreign bodies into the urethra is not uncommon but seldom is the stimulant object lost in the canal. The following case is of interest because two long darning needles were thus deposited in the deep urethra of a seven-year-old boy. Yet it is reported because it admirably illustrates (1) the usual complications of urethral foreign body, (2) the likelihood that the erroneous diagnosis of gonorrhea will be made and (3) the type of treatment required when the foreign body is large or periurethral suppuration exists.

CASE REPORT

T. G., colored male, aged seven years, on July 3, 1932 was admitted to the Essex County Isolation Hospital because of a profuse urethral discharge of three days' duration. There was moderate burning on urination. There was no history of sexual exposure nor of infectious contact at home. Eight days after admission to the hospital the boy admitted that five weeks before he had introduced two darning needles into the urethra.

The *past history* was negative except for an attack of pertussis.

The *physical examination* was negative except for a long prepuce and a profuse creamy urethral discharge.

Laboratory Examination: Urethral smears revealed innumerable pus cells but no organisms. The urine contained a moderate number of pus cells. The Wassermann reaction was negative.

The boy was put to bed without local treatment. Five days after admission a tender nodular swelling appeared in the deep bulbous urethra, extending anteriorly to just behind the penoscrotal junction. Three days later the mass was hard and firm and at this time the boy confessed the introduction of the needles. Fourteen days after admission to the hospital I was called to see the boy, at which time a well-developed periurethral abscess of the bulbous portion was found. The anteroposterior roentgenographic view showed a cruciate shadow below the symphysis level (Fig. 1). A diagnosis of periurethral abscess secondary to foreign body was made.

Under open drop ether anesthesia a 12 F. sound was passed as far as the obstructing object, the scrotum was pulled forward and a median incision was made over the deep bulb. The periurethral tissues were markedly indurated and the center of the mass was grumous. Following urethrotomy the two needles were removed. The skin was loosely drawn together. A 15 F. sound was then easily introduced to the bladder.

Convalescence was uneventful. There was moderate urinary leakage through the urethrotomy wound for seven days; the boy was discharged healed August 3, 1932.

COMMENT

Urethral masturbation by the introduction of foreign bodies is most common in girls who usually use hairpins. Boys most often resort to smoothly rounded objects such as glass-headed pins; the greatest sensation is achieved when the verumontanum is irritated. In my patient, two

* From the Department of Urology, Essex County Isolation Hospital, Belleville, N. J.

darning needles were introduced to the posterior urethra but were lost. A foreign body urethritis developed which simulated

Fig. 1. Anteroposterior view which gives no clue to size or exact site of foreign bodies. A lateral view, neglected in this case, should always be made.

acute gonorrhea in all respects except that gonococci could not be found. Despite the negative bacteriologic findings and because gonorrhea is common in colored children, this diagnosis was persisted in until the boy confessed his past performance. Meanwhile, a moderate sized stone was deposited about the pointed end of each of the needles (Fig. 2) and secondary periurethritis led to abscess formation.

The diagnosis of urethral foreign body is usually based on the history. Sometimes the object can be palpated; in this case, when the diagnosis became evident the needles were obscured to palpation by periurethral abscess. Rectal examination was neglected. Roentgenography should include anteroposterior and lateral views. Unfortunately, in this patient lateral exposures were not made. The anteroposterior view gives no clue to the size or shape of the foreign bodies nor does it indicate the stones, the delineation of which might be

Fig. 2. Needles removed from deep urethra. A stone had formed over point of each needle. Needles had been introduced smooth (eye) end first.

expected in a lateral view. The caliber of the juvenile urethra rarely permits satisfactory observation by tubular endoscopy.

Removal of the foreign body is the treatment; it usually requires urethrotomy and always does when periurethral suppuration exists. The latter must be widely incised. Although urethral foreign bodies in adults may often be removed through an endoscope, the caliber of the juvenile urethra mitigates against this method. Sometimes needles and pins may be removed by forcing the pointed end through the ventral urethra. When this is impracticable, as with a glass-headed pin, the point is forced externally through the urethral wall sufficiently to permit a reversal of the direction of the object. The smoother end is then milked forward to the meatus and extracted.

Following either manipulation or urethrotomy removal of the urethral foreign body, stricture is likely to ensue. The best prophylaxis against this is periodic dilatation with sounds. A clean longitudinal urethral incision will not cause stricture; periurethritis will. If the normal urethral caliber is maintained postoperatively, there is little danger of urethral fistula.

FRACTURE OF ODONTOID PROCESS OF THE AXIS

REPORT OF CASE WITH BONY UNION

CHARLES S. NORBURN, M.D. AND J. DONALD MACRAE, M.D.

ASHEVILLE, N. C.

A REVIEW of the literature will impress upon anyone the importance of an early diagnosis and adequate treatment of all fractures of the odontoid process of the axis. Untreated patients, after the first few days, may have little discomfort and may be able to go about their work as usual, but in the great majority of instances these untreated cases terminate fatally in from a few weeks to many years, from injudicious movement or from myelitis caused by irritation or callus.[1]

The purpose of this paper is to describe a method of roentgenographic study when the diagnosis is in doubt; and also to report a case of odontoid fracture, which is unusual in that there was no displacement and in that it ended in recovery with bony union in the normal position. Mixter and Osgood after their extensive study doubted if bony union ever occurred.[2]

CASE REPORT

The patient, D. J. K. is a white man, aged fifty-eight years, who weighed 195 lb. On March 6, 1931, he was thrown, head first, through the top of a touring car as it ran over an embankment. The soft dirt of a field broke his fall and he did not lose consciousness.

He was taken to a hospital, suffering from epistaxis and pain in the right chest, shoulder and neck. Examination showed that his right clavicle and one rib on the right side were fractured. There was considerable soreness in the back between the shoulders. At this time and during the following three weeks he had the symptom of being unable to raise his head from the pillow without assistance.[3] Rotation of the neck was limited and any motion caused some pain. There were no cord symptoms.

Three weeks after the injury the patient was brought to our hospital. At that time, roentgenographic examination showed a fracture of the right clavicle and a clouding of the mastoid cells on the right.

Several films were taken of the axis before the diagnosis of fracture of the base of the odontoid was finally made. In addition to the standard views of the first and second cervical vertebrae, a lateral exposure was made, with the head bent forward (flexed) (Fig. 1) and another with it bent backward (extended) (Fig. 2). The one in the flexed position showed the odontoid to be tilted backward, while the one in the extended position showed it to be tilted forward. The tilting thus seen was contrary to what we expected to find. However, we explained it as follows:

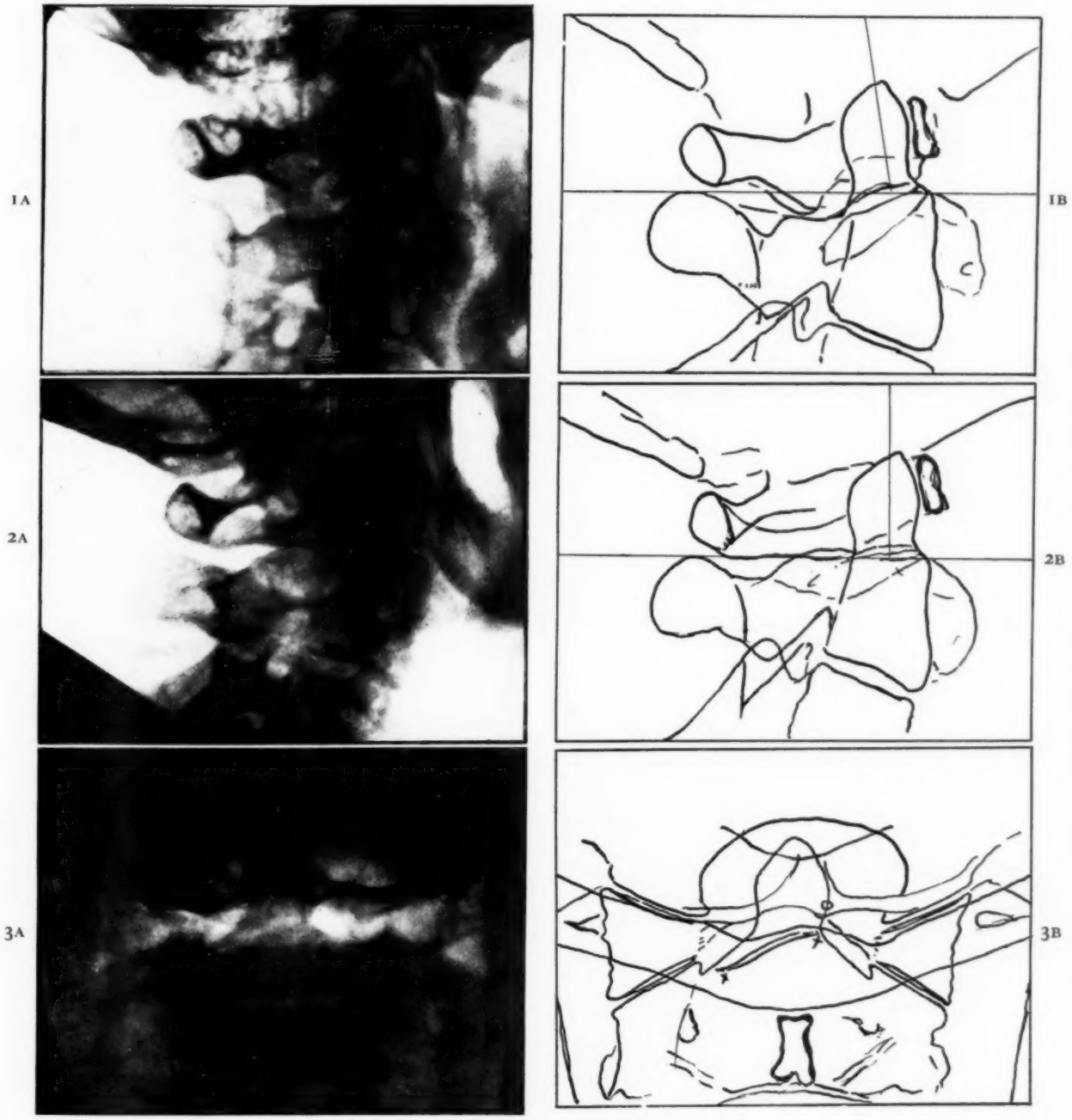
Most of the flexion and extension in the neck takes place in the lower cervical vertebrae. However, when either motion is forced, the atlanto-occipital articulation moves to its limit and the atlas is carried forward in extension and backward in flexion. In extreme flexion or extension the atlas moves almost as a rigid part of the occiput, revolving on an axis a short distance above the condyles. Thus the anterior arch presses backward against the ondotoid during flexion and the check ligament presses forward against the odontoid during extension. The standard view through the open mouth (Fig. 3) shows an oblique fracture through the base of the process.

The patient was placed in a plaster jacket, with a high collar extending up on the occiput and on either side to the ears and supporting the mandible in front. After about a week the jacket was split on either side to permit removal for bathing. It was, however, worn day and night.

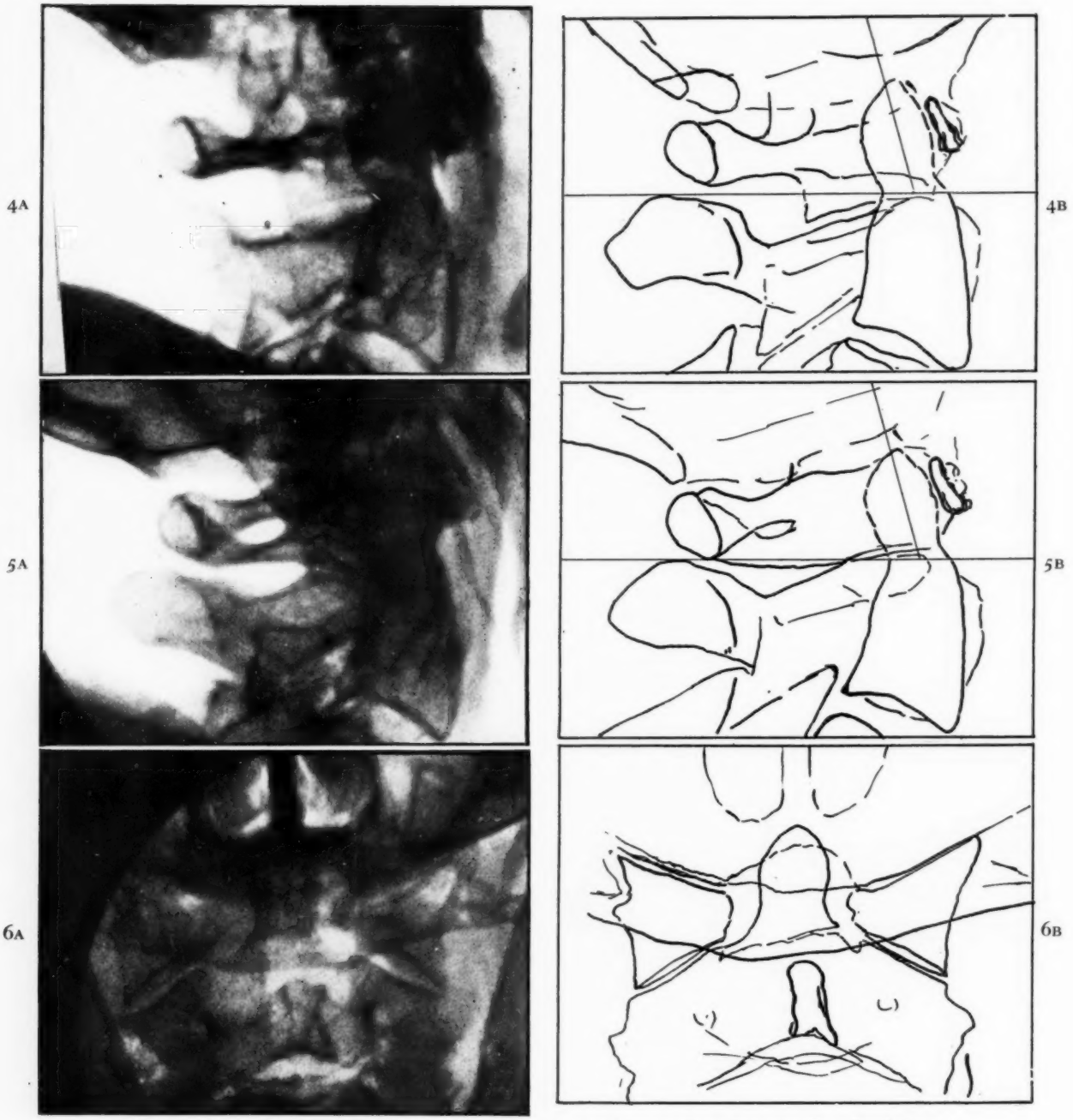
Three months after the injury, the patient was fitted with a celluloid jacket having a high collar. This was worn for about a month, when he began to wear a brace prescribed by Dr. A. P. C. Ashhurst. The brace consisted of a leather band about the forehead and occiput, supported by a steel rod attached to shoulder

and hip braces and passing along the spine, following the normal curves. This brace permitted a very small degree of rotation, flexion and extension, but prevented any great or sudden motion, which might cause complete separation of the odontoid fragments. It was not worn at night. Three and a half months later, that is, seven months after the injury, the brace was discarded.

At the last examination, nine months after the injury, the radiographs showed bony union in the normal position, with a dense line of callus at the site of the former fracture. (Figs. 4, 5, and 6.) The patient can turn his head



Figs. 1, 2 and 3. Roentgenographs and tracings.
Fig. 1. Lateral view. Head flexed, showing backward tilting of odontoid process.
Fig. 2. Lateral view. Head extended, showing forward tilting of odontoid.
Fig. 3. Anteroposterior view, showing fracture line obliquely across base of odontoid.



FIGS. 4, 5 and 6. Roentgenographs and tracings showing bony union nine months after injury.
FIG. 4. Lateral view. Head flexed.
FIG. 5. Lateral view. Head extended. No tilting of odontoid process is shown.
FIG. 6. Anteroposterior view, showing dense callus formation along line of fracture.

from side to side through about 75°. (While his neck is short and stout, his normal rotation should be 90° to 100°.) There is also slight limitation in extension and flexion. The patient has been advised not to move his head to the limit in any direction and he is careful to follow this advice.

DISCUSSION

Union of odontoid process proper with the body of the axis occurs about the third year but it is not complete until a year or two later. The center of the junction is occupied by a small disk of cartilage, which exists, surrounded by bone, until advanced age.[4] Because of this defect and its associated inherent weakness, most fractures of the odontoid occur at its base.

In our patient there was sufficient trauma to fracture the odontoid process but for some reason the displacement was minimal. We believe that the short, heavily muscled neck of this individual acted as a splint and prevented displacement of the fragments or dislocation of the vertebrae which so frequently accompanies these fractures.

When the roentgenographic examination does not present a clear-cut picture of a fracture of the odontoid and such a fracture is suspected, we suggest that true lateral films be made in forced extension and forced flexion to demonstrate the mobility of the process. This examination, we believe, will be helpful in clearing up doubtful cases of fracture of the base of the odontoid.

We are endebted to Dr. Henry K. Pancoast of Philadelphia for his courtesy in reviewing our films.

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GASTRO-PLEURO-CUTANEOUS FISTULA FOLLOWING GUNSHOT WOUND

CASE REPORT

W. H. PARSONS, M.D., F.A.C.S. AND W. G. WESTON, M.D.

VICKSBURG, MISS.

GUNSHOT wounds of the upper abdomen are fairly common. Coincident to such injuries, damages to the intra-abdominal organs may occur and should always be considered possibilities.

It is particularly important to know or to determine, when possible, the position of the patient at the time the wound was received and the apparent angle at which the bullet has entered. This is particularly true in cases where the missile does not emerge from the body.

The bullet may take a downward, a straight, a lateral or an upward course depending on the angle at which it penetrates, its velocity and the structures with which it comes in contact.

Thus it may enter the chest, range downward and damage one or more of the abdominal viscera or it may enter the abdomen primarily, range upward, and invade the thoracic cavity, with or without injury to the structures contained therein.

Shipley[1] states that a fairly common suicide injury is caused by a bullet passing below and to the outer side of the heart, penetrating the lung, piercing the diaphragm and wounding the stomach, spleen or left kidney.

Gastro-pleuro-cutaneous fistula following a gunshot wound is apparently a relatively uncommon condition. In a recent rather extensive survey of the literature, no case reports of this condition were found by us.

Graham,[2] Lilienthal[3] and Hedblom[4] state that they have had no personal experience with such a case. It was suggested by Graham that possibly such a case report could be found in the records of the Medical Corps of the U. S. Army, but review failed to find mention of the condition.

[1] Shipley, A. M. In: Lewis. Practice of Surgery. Hagerstown, Md., Prior, 4: Chap. 10.

[2] Graham, E. A. Personal communication.

[3] Lilienthal, H. Personal communication.

[4] Hedblom, C. A. Personal communication.

CASE REPORT

L. S., single, female, colored, aged twenty-three, admitted to Vicksburg Hospital December 27, 1931.

Chief Complaint. Shortness of breath following gunshot wound.

Present Illness. The patient was shot in the left side of the chest two days previous to admission, and according to the patient and her relatives the person firing the shot was on the same level with the patient and shot her while she was standing. Immediately after the injury, the patient became short of breath and noticed a sucking sound with respiration. She was treated elsewhere for two days and was then brought to the Vicksburg Hospital. At the time of admission she was complaining of marked dyspnea and of inability to breathe while lying down.

Previous Health. Had always been good. There had been no serious past illnesses and no previous injuries.

Family History. Not remarkable.

History by Systems. Negative.

Physical Examination. Temperature 102°F. Pulse rate 140. Respiratory rate 44. Inspection revealed a well-developed but poorly nourished female colored adult, acutely ill and complaining of shortness of breath and of inability to breathe while lying down. There was a sucking sound present with respiration.

Head. Not remarkable.

Mouth. Dental caries; otherwise negative.

Neck. The trachea was displaced to the right.

Chest. Inspection: Anteriorly, in the fifth interspace, 4 cm. from the midsternal line, there was a wound 0.75 cm. in diameter due to the recent gunshot injury. The wound had closed. Posteriorly, just below the inferior angle of the scapula in the eighth interspace, there was an open wound 2 cm. in diameter, from which shreads of tissue were hanging, and from which a small amount of clear fluid was escaping.

Lungs. Inspection showed marked limitation of expansion on the left and rapid shallow respiration; the rate was 44 per minute. There was a plainly audible sucking sound present with respiration. Palpation revealed the absence of tactile fremitus over the entire left lung and an apparent increase above normal on the opposite side. A decrease in the width of the intercostal spaces was also noted on the left side. The percussion note was hyperresonant throughout the left chest with the exception of slight dullness posteriorly in the interscapular area. The note was resonant throughout on the right side.

Auscultation. Sounds were obscured by a sucking noise present with respiration, but breath sounds were practically absent on the left and somewhat increased on the right. Vocal fremitus was also markedly diminished on the left. No râles were heard in either lung.

Heart. Inspection showed a visible pulsation of the apex in the fourth interspace, 3.5 cm. from the mid-sternal line. Palpation confirmed the inspection in the location of the apex beat. No thrills or shocks were felt. Percussion of the heart revealed displacement of that organ 3 cm. to the right of the midsternal line in the fourth interspace. Percussion to the left confirmed the inspection and palpation. Auscultation revealed a rate of 140, with regular rhythm and without murmurs.

Blood pressure: Systolic 112, diastolic 76.

Abdominal examination revealed a slight rigidity of the left rectus in its upper half, with only slight tenderness. The remainder of the abdominal examination showed nothing remarkable.

Vaginal examination revealed nothing of significance.

Extremities were not remarkable.

Nervous System. Reflexes were active and equal on the two sides. Gordon, Oppenheim and Babinski reactions negative.

Laboratory Findings. Blood for Kline and Young reactions was negative. Blood for Kahn reaction was negative.

Blood: Some platelets; hemoglobin 60 Sahli; slight anisocytocis; slight poikilocytocis; slight polychromatophilia; rare microcytes; rare macrocytes; rare normoblasts; leucocytes 11,700; small lymphocytes 17; large mononuclears 6; neutrophiles 77 (45 B.F.).

Blood Chemistry. Chlorides, 468.75 mg. per 100 c.c.

Urine. Specimen 175 c.c. Color dark green; appearance cloudy; reaction slightly acid; Sp. Gr. 1.022; indican large trace; albumin large trace; Sugar none; few round epithelial cells; sediment 2 per cent slightly heavy yellow; numerous squamous epithelial cells; some bacilli present.

Progress Notes. Dec. 27, 1931. A tentative diagnosis of traumatic pneumothorax, left side, was made. The patient was treated conservatively because of the gravity of her condition and the evidence of toxicity present. Morphine sulphate gr. ¼ was given repeatedly, fluids in large amounts by mouth were forced and small amounts of 10 per cent glucose in the vein were given cautiously. The wound in the chest was sealed with rubber dam and collodion.

Dec. 28, 1931. The patient's condition seemed somewhat improved. Fluids were given more freely by mouth and in the vein. The temperature, pulse and respiration remained about the same. The amount of urine voided seemed to be considerably below the fluid intake. Three hundred cubic centimeters of citrated blood were given in the vein. Venoclysis was started.

Dec. 30, 1931. The condition of the patient was about the same. Venoclysis was discontinued. Fluid intake 5310 c.c. Urinary output 930 c.c. It was noted that the bed was extremely wet at all times although the patient was not incontinent. The rubber dam and collodion had come off and the dressing over the wound was wet. The possibility of a gastro-pleurocutaneous fistula presented itself. Accordingly, 500 c.c. of water, colored with methylene blue, were given by stomach tube, and within a few minutes the colored solution was seen coming from the wound in the back.

Treatment. The question of treatment next presented itself. In view of the poor condition of the patient, it was decided to treat her conservatively, hoping that surgery could be done later. A semi-Fowler position was instituted and fluids by mouth were discontinued, all fluids being given subcutaneously or intra-

venously, keeping the fluid intake above 2000 c.c. in twenty-four hours.

Jan. 3, 1932. The patient was showing no improvement; the heart rate remaining persistently high (140 or over). The patient had been digitalized. The respiratory rate also remained elevated. Surgery was decided on in the hope of closing the stomach wound. It was planned at the earliest possible time, following this procedure, to close the wound in the chest, instituting closed drainage. We then proposed to divide the left phrenic nerve and repair the diaphragmatic wound. The sequence outlined appeared to us to offer the best solution to the several problems present.

Jan. 4, 1932. Operation was done under local anesthesia by one of us (W. H. P.).

Closure of Perforations of Stomach. Jejunostomy. Local anesthesia was induced in the usual manner. The abdomen was opened through a transrectus incision just to the left of the mid-line. When the abdomen was opened, the stomach was found to be situated rather high; and when the lesser peritoneal cavity was entered, a diffuse peritonitis was found. The posterior wall of the stomach, just above the greater curvature and at about its mid-portion, was firmly attached to the diaphragm. The adhesions were separated and two perforations of the stomach were found, one being near the cardia and quite difficult of approach. The perforation adjacent to the pylorus was sufficiently large to admit the little finger. This perforation was adherent to the left lobe of the liver and extended through the diaphragm. The tissues were rather crisp. The second perforation was more to the left, and was smaller. Both perforations were closed with black silk and the suture lines were protected by omentum. No attempt was made at this time to repair the diaphragmatic defect. Vaseline gauze was packed lightly into the opening. A rubber dam was inserted between the stomach and diaphragm and the packing and rubber tissue emerged to serve as a drain. The usual wound repair was done. The patient tolerated the operation fairly well. Soon after her return from surgery, however, the heart rate increased to 168, the temperature to 105.8°F. and the respirations to 45 per minute.

Jan. 5, 1932. The patient was treated throughout the night for hyperpyrexia, with cool sponges, ice caps and alcohol rubs, without effect, and death occurred at 8:55 A.M., twenty-four hours after operation and eleven days after the original injury.

Permission for a post mortem was denied.

NEW INSTRUMENTS

APPARATUS TO LIFT PATIENTS SUFFERING FROM PAINFUL CONDITIONS

E. MacD. Stanton, M.D., F.A.C.S.

SCHENECTADY, N. Y.

THE accompanying illustrations show the essential features of an apparatus which I use to aid in the nursing care of patients with fractured hips, backs and other conditions in which it is difficult to raise the hips and body from the bed.

The essential unit in this apparatus is shown in Figure 1. It was conceived and designed by Mr. Fred Scheidegger, an ex-army stretcher bearer and hospital attendant, with the idea of moving wounded soldiers short distances on the backs of individuals instead of on two-man stretchers. While he was demonstrating the apparatus, it occurred to me that it might have a valuable peace-time use as herein described.

The apparatus opens and closes on the same principle as a pair of ice tongs. Instead of the narrow tongs, the blades are 17 inches wide. They are made of steel frames over which are placed washable canvas covers. Without the patient being moved, the jaws of the tongs are opened and adjusted to the patient's body. As the lifting force is applied, the jaws tend to close and thus the body is held firmly but comfortably in the apparatus.

The lifting force is applied by means of a block and tackle, the kind used by farmers to stretch fence wire, which can be purchased complete, rope and all, at hardware and implement stores for about $1.75. An essential part of this block and tackle is the tension lock which enables the farmer to stretch the wire and hold it stretched until fastened to the posts and which likewise enables the nurse to keep her patient suspended at any height as long as desired.

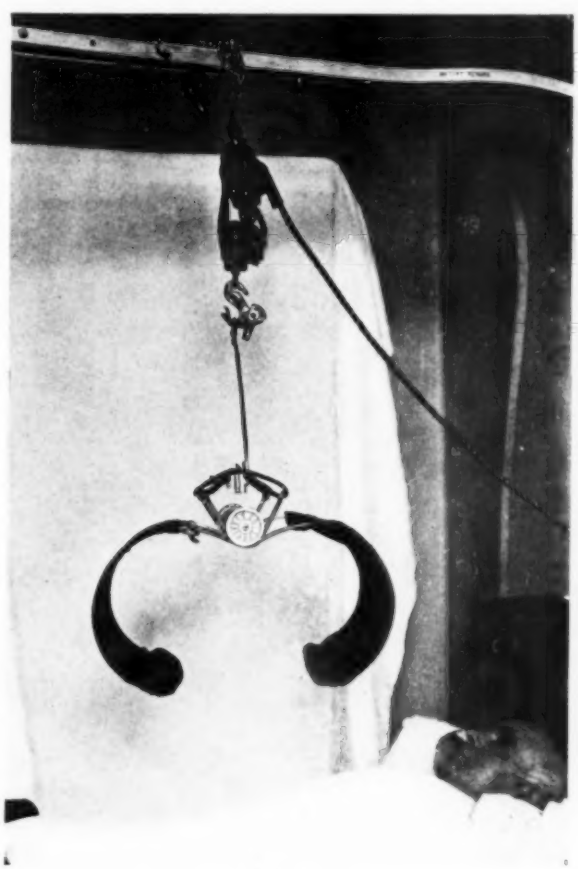

FIG. 1.

Mr. Scheidegger has also designed a frame from which the lifting parts are

suspended. This frame can be fitted to any hospital bed and is much more rigid than the ordinary Balkan frame. However, a Balkan frame of sufficient strength will serve the purpose very well.

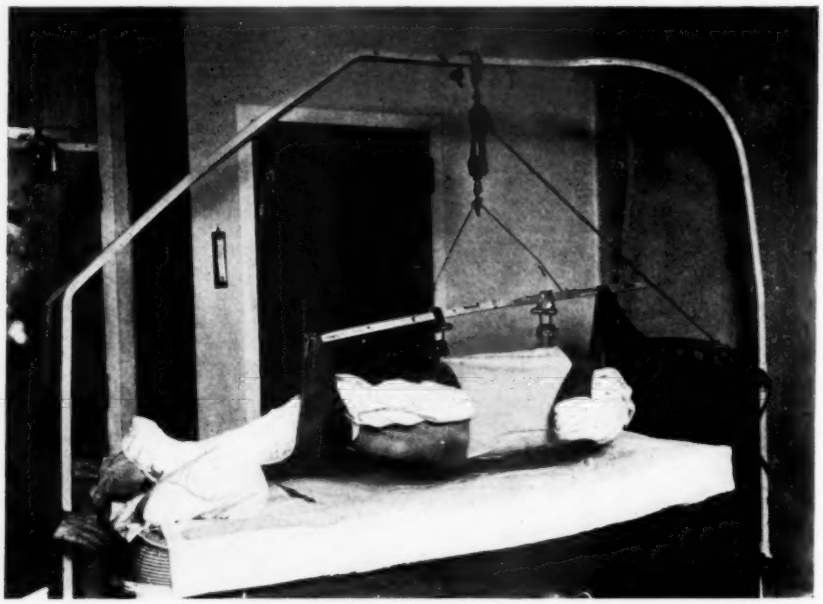

Fig. 2.

Figure 2 shows a patient suspended well above the mattress with head and legs supported by slings hung from the same bar used to carry the body holder. This long bar with head and leg attachments has proved very useful but the head and leg attachments are usually not necessary when the patient is raised for such procedures as the use of a bed pan.

The ultimate test of an apparatus such as is herein described is the attitude of nurses and orderlies toward its use. If it is not practical and really worthwhile, it will soon find a forgotten resting place somewhere in the hospital. The nurses and orderlies who have had experience with this apparatus have all been enthusiastic over its use.

The tong-like body holder can be applied without moving the patient. The block and tackle gives four times the lifting power so that a nurse can readily handle the patient without assistance and the locking device enables her to leave the patient suspended while she rearranges mattresses and bedclothes or does whatever else may be necessary. It is quite possible for the patient to lift himself by means of the block and tackle and it is not unusual to find him helping the nurse in this way.

The American Journal of Surgery

PUBLISHED MONTHLY BY PAUL B. HOEBER, INC., 76 FIFTH AVENUE, NEW YORK, N. Y.
FOR THE AMERICAN JOURNAL OF SURGERY, INC.
Editor: THURSTON SCOTT WELTON, M.D., F.A.C.S., NEW YORK

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EDITORIAL

A MESSAGE TO RADIOLOGISTS

TO combat the inroads upon Radiology by laymen, corporations and others not licensed to practice the healing art, roentgenologists of California on June 11th formed the Pacific Roentgen Club. Basing their organization upon the principle that Radiology is the practice of medicine and as such is due at all times full recognition as a learned and dignified branch of the profession, the roentgenologists have banded together in an aggressive association.

Formation of the club took place at Santa Maria, where representatives from all sections of the state gathered for a full discussion of problems affecting Radiology in its relationship with other branches of medicine and the general field of public health. Lowell S. Goin, M.D. of Los Angeles was named chairman; L. H. Garland, M.D. of San Francisco, secretary, and these two with Henry Snure, M.D. of Los Angeles, John Lawson, M.D. of Sacramento and Robert Stone, M.D. of the University of California, form the executive committee.

"There have been constant inroads upon Radiology by laymen, nurses, corporations and others not scientifically trained in this highly important branch of medical practice," said a statement issued from the meeting. "We as Radiologists object to this for several reasons. First, from the standpoint of public health. The *x*-ray is a potentially dangerous instrument, as is the scalpel of the surgeon, the hypodermic of morphia and the anesthetic. It is because

these are in skillful and careful hands that they are of benefit to humanity—a thing equally true of the roentgen rays. The danger is not only one of physical damage to tissue (negligible in skilled hands), but the less spectacular and more commonly encountered danger resident in the absurd diagnoses by incompetent persons.

"We maintain that Radiology, being as it is, the diagnosis and treatment of human disease, is the practice of medicine, and as such, should be solely in the hands of those licensed to practice the healing art.

"We object to the exploitation of any physician for the gain of any non-medical concern. Under ruling of the California courts a corporation cannot engage in the practice of medicine. Nevertheless corporations do practice Radiology, which we maintain to be a part of the practice of medicine.

"*X*-ray diagnosis is one of the greatest advances that has been achieved in the practice of medicine. Radiation therapy combined with good surgery, offers the only chance we know of today for the cure of malignant disease. If Radiology is degraded by falling into the hands of lay people and is forced down to the state where the Radiologist is merely the servant of a corporation, the high standards we have set up will fall and not only medicine but the general public will suffer a distinct loss.

"It is to prevent these things and to stand firmly upon our rights as practitioners of medicine that we have organized. We propose to take such steps as may be necessary to prevent further inroads upon Radiology. We intend to maintain and improve our present standards and to have at all times the recognition due us as a learned and dignified branch of medicine. The California Medical Association has recognized this officially in Resolution No. 5 of the House of Delegates, adopted at the recent annual meeting and printed on page 465 of the June issue of California and Western Medicine."

The organization is being rapidly perfected and a program is now being mapped out to carry through the principles upon which it is founded.

Organizations formed in other states along these outlines, would be a distinct benefit to organized medicine.

JAMES T. CASE, M.D.

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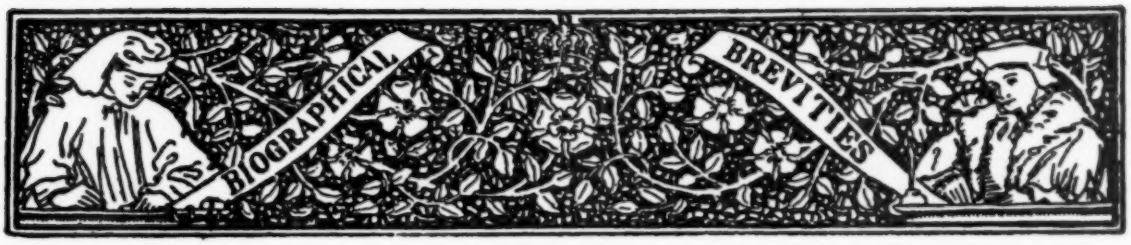

AMERICAN PHYSICIANS

GEORGE EMERY GOODFELLOW*

FATE allots to few the varied and full life of George Emery Goodfellow who was born at Downieville, Sierra County, Calif., December 23, 1855. His adventures as a citizen and physician at Tombstone, Arizona, alone, would supply more than sufficient material for several exciting novels.

In 1868 he was sent to live with a relative at Meadville, Pa., and to attend school. In 1870 his family moved to Treasure City, Nevada, and George was called home and entered the College of Engineering at the University of California. He stayed a year and in 1872 entered the U. S. Naval Academy at Annapolis. He claimed he was insulted by a negro midshipman, who was later dismissed, and he struck a blow that precipitated his fellow student down a flight of stairs. For this he was expelled (Dec. 12, 1872) but President Grant said he'd reinstate him once the agitation died down. He never did. Meanwhile, George began to read medicine with a cousin in Meadville, Pa. He graduated in medicine from the University of Wooster, Cleveland, Ohio, Feb. 24, 1876.

Goodfellow married Katherine Colt of Meadville and went to Oakland, Calif., where he tried in vain to build up a practice. He moved to Prescott, Arizona, as company doctor to a mine. In 1880 he went into private practice at Tombstone, Ariz., where he became coroner. Inasmuch as Tombstone was called "the condensation of wickedness," Goodfellow "had a greater practice in bullet wounds of the abdomen than any other man in civil life in the country . . . and became a pioneer in the development of abdominal surgery for gunshot wounds." He, also, was a pioneer in plastic surgery, having reconstructed a nose which had been flattened by an accident. He moved to Los Angeles in 1896.

He was a pioneer in advocating the outdoor treatment of tuberculosis. He opened a small hospital in the Orndorff Hotel, staffed by a nurse and his thirteen year old daughter as assistant. "His prostatectomy operation became widely known as 'the operation'" and Dr. Hugh Young of Baltimore gives Goodfellow credit for being the first to do a successful prostatectomy by the perineal route.

Goodfellow is reported to have been directly responsible for the surrender of Santiago de Cuba by General Toral on July 17, 1898 (Spanish American War).

He moved to San Francisco in 1900. He was said to hold the "same contempt for a drunkard as for a prohibitionist." He taught himself to speak fluently Spanish, German and French.

In 1904 he reported 78 perineal prostatectomies with but 2 deaths, and no cases of postoperative incontinence or fistula.

He was a pioneer in spinal anesthesia.

Just prior to the San Francisco earthquake and fire he was betrayed by supposed friends in a real estate deal and lost nearly everything. A friend made it possible for him to become Chief Surgeon of the Southern Pacific Railroad in Mexico.

He died in the Angelus Hospital (Los Angeles) December 7, 1910.

T. S. W.

* For a full life of Dr. Goodfellow the reader is referred to the May, 1933 issue of the *Annals of Medical History*.

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

CAVE MAN EXERCISE

C. S. Butler, M.D., Capt., M.C., U.S.N.

Brooklyn, N. Y.

Sleep, temperate habits and judicious exercise are factors of the greatest importance in prolonging life and making it interesting. The testimony of past ages and all exact physiological experimentation of modern times show the truth of this statement. Generalizations running counter to it are, however, not unusual as, for example, the statement that such and such a great man "got along" on four or six hours sleep per day and, therefore, mankind generally should be able to do likewise.

Since man learned how to grasp objects other than the limb of a tree, the most important ones he has grasped have been the hoe and the ax. These two have complemented each other from the dawn of humanity to the present. The hoe has enabled man to dig a food supply from unwilling soil, the ax has protected him while he did so. If it is the hoe that has enabled him to win the earth, it is the ax which has given him the leisure to win the universe. Had it not been for the ax, the Millet-Markham picture of "The Man With The Hoe" would be a true portrait of present-day man. The ax has therefore acted as implement, tool and weapon, and the reason man has occasionally consented to beat the sword into a ploughshare is because he has always had the ax handy in case of emergency.

Malthus (1766–1834) over a century ago discovered the principle (1798) and stated the law that "population treads ever on the limits of subsistence." If overpopulation compels, man has never yet hesitated to take by force the territory necessary to satisfy this compulsion. The ax is his protection against this tendency and it is not a *cure* but a means of diverting it. This diversion has resulted in widening the threshold of man's food supply until it now extends irregularly over the earth from the equator to the polar snow lines.

The ideal will be reached, as far as productive efficiency is concerned, when every portion of the earth's surface is supporting its greatest possible population in health and happiness with a balanced birth and death rate. This goal is a long way off, and until it is reached and man may speak as a citizen of the world instead of an individual or a national, it is well to refrain from throwing away the ax which has been of such vital service thus far. It is but stating the evident to say that agreements, treaties, covenants and oaths are rendered null and void when faced with the law of species survival and the compulsion to reproduce.

But what has all this to do with the subject "Cave Man Exercise"? It is to remind the reader of the importance of the ax in history and to recommend to him this age-old implement as a ready means of taking exercise for that large group of busy men who, having passed the baseball and tennis periods of life and arrived at the age of fifty, finds it impossible for one reason or another to take advantage of that ideal type of exercise and recreation for those above fifty, namely, golf. Many of us cannot give up the time necessary to get the best effects from golf. Many of us have not the money to indulge in it, while there is a multitude of men to whom intellectual work is sufficient *recreation* but who *must have* physical exercise if they are to avoid cracking up too soon after fifty.

Fig. 1. This looks like primeval forest; it is actually near the center of America's most densely populated metropolitan area, in the grounds of the Naval Hospital, Brooklyn, N. Y. Note section of garden hose on top of woodpile. One should be able to cut such a section three times out of five at 4 to 8 yards.

There is no more pitiable object than the doddering old man waiting to fall into the grave. It must have been from a contemplation of his unfortunate state that the pagan satirist, Juvenal, nearly 2000 years ago, expressed a human yearning of the ages in the words, "Our prayers should be for a sound mind in a healthy body." To acquire these, we should avoid too strenuous athletics while young, too little exercise after fifty and at all times suppress and keep in its proper place the element of competition. Too much competition makes of exercise, not a recreation, but a worry and a drain.[1]

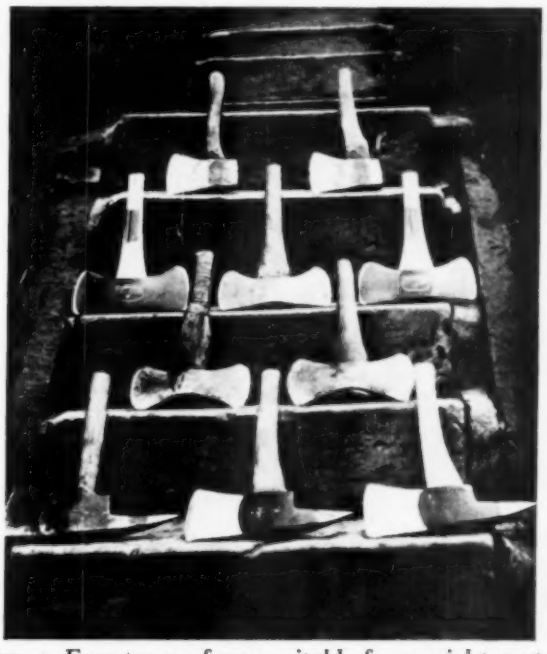

Fig. 2. Four types of axes suitable for special targets.

Some races have used the ax as a weapon in hand-to-hand combat only, and in some cases battle axes have required both hands in the wielding. Generally, among primitive peoples, the ax has been employed both in hand-to-hand combat and as a missile. The "francisca," at one time the national weapon of the Franks and the tomahawk of the North American Indians, were used in both ways. As a missile, the ax was not as accurate as the arrow, but

[1] See article entitled "Play Hard" (what the competitive spirit has done for us), by John R. Tunis. *Atlantic Monthly*, January, 1932.

we know from our own American experience that the tomahawk was a deadly weapon of considerable precision when thrown at short range. Now, if they used the ax in war, the wild peoples must have devoted some time to target practice, and it is in imitation of this that the present form of recreation was devised.

The illustrations which accompany this article together with their legends will, it is thought, be sufficiently explanatory. The outfit in its simplest form consists of the but-end of a log to act as target and one, or better two axes. The distal end of the target may rest against a terrace or by taking a long portion of log, the outboard end may be secured by abutting it against a sturdy stake driven in to hold it. If there is space available in the back yard, the more ambitious "target range" shown in Fig. 1 may be set up.

As to the weight and other characteristics of the axes, it is best to begin with the common ax shown in the top tier of Fig. 2. A 3-pound ax is best for the beginner and the over-all length of ax and handle should be not greater than 16 inches. The reason is because there is no advantage in trying to tumble the missile more than one complete turn between the hand and target. If the handle is too long, it is constantly interfering with the completing of this one revolution of the ax.

One must have a rasp at hand in order to smooth off any roughness of the handle, caused by striking it against the target. It is not well to throw the ax until the handle is perfectly smooth. After learning to put the edge upon the target regularly, one may try driving a spike into the target with the head of the ax. When practice has enabled the beginner to hit the target with the edge or the head at will, he is in position to use any kind of a hand ax in a great variety of ways which the imagination and ingenuity of the thrower may suggest.

Three, 3½ and 4-pound axes are the most desirable weights. One should always have in mind the question of the ax glancing off the target and striking someone in the vicinity. If children are about, they may walk into the swing of the ax from behind the thrower. It is only necessary to mention such precautions in order to emphasize their importance.

This form of exercise is convenient, interesting and effective, for it brings into operation nearly all muscular groups in the body. It requires a stance and gives a twist to the torso which is most effective in subduing an uproarious waist line. From having followed this type of exercise for nigh onto ten years, I am prepared to state that one may crowd into half an hour of this sport as much exercise as would require half a day for golf or some of the milder forms of athletic activity.

BOOK REVIEWS

CARDIOVASCULAR PAIN AS A BIOCHEMICAL PROBLEM. By Gordon Lambert, B.A., M.D. (Cantab.). Foreword by Maurice Alan Cassidy, M.D. London, H. K. Lewis & Co., Ltd., 1933.

The author has original conceptions which he is not afraid to present and it must be confessed that he makes out a good case for his ideas.

Most physicians will agree with the writer of the Foreword who says that while he feels bound to differ with the author in some instances he finds himself in complete accord with the thesis as a whole.

There will be little exception taken to the author's view that "There is a unity, or common link, in all forms of cardiovascular pain. That link consists in an abnormal condition of the blood supply to the myocardium. The abnormality is not identical in all cases. The problem is, indeed, a very complex one, demanding abstruse biochemical research."

The little book is interesting and stimulating and will be found thoroughly worthwhile by all interested in this subject.

A TEXT-BOOK OF NEUROPATHOLOGY. By Arthur Weil, M.D. Phila., Lea & Febiger, 1933.

A well-planned book on a subject that is becoming more and more important. Complete, concise and well illustrated, this book fills a definite niche in American Medical Literature.

OPERATIVE SURGERY, THE ABDOMEN AND RECTUM. By Martin Kirschner, M.D. Authorized Trans. by I. S. Ravdin, M.D. Phila., J. B. Lippincott Co., 1933.

The second volume of Kirschner's "Operative Surgery," devoted to the abdomen and rectum, appears with a Foreword by the German author giving a long apology and explanation for the delay in its publication. Since the issuance of the first volume, the author has moved from Konigsberg to Tubingen where his time has been devoted to the erection of a large surgical clinic which has, of necessity, handicapped his literary efforts. It is rather surprising under the circumstances that this volume should be as thorough and as complete as it is. The illustrations which are a special feature of the book are remarkable not only for their careful selection but also for their splendid reproduction.

Further volumes of this work will be looked to with interest but it may be emphasized that each volume is thoroughly complete in itself and the subjects treated are amply and fully covered.

FRACTURES. By Paul B. Magnuson, M.D. Phila., J. B. Lippincott Co., 1933.

This work on Fractures is confined entirely to the author's own experience and is not burdened with long references to the literature nor too long discussions of untried procedures. Intended for the man who first sees a fracture, the book is concise and practical.

The author's great experience and sound judgment are displayed in every page. The book is exactly the kind for reference when one is confronted with a case and in doubt as to just what to do.

There are over 300 well-selected and well-reproduced illustrations.

MEDICINE IN CANADA. By William B. Howell, M.D. Clio Medica IX. N. Y., Paul B. Hoeber, Inc., 1933.

NUTRITION. By Graham Lusk, M.D. Clio Medica X. N. Y., Paul B. Hoeber, Inc., 1933.

These additions to the Clio Medica series reach a high water mark for interesting reading. In fact, each of these small volumes, under the editorship of E. B. Krumbhaar, deserves a place in every physician's library.

Doctor Howell, in his Medicine in Canada, has accomplished that rare thing in writing—he has carefully chosen his facts and presents them to the reader in an orderly, scholarly

way, but at the same time he has added a good sprinkling of spice, which makes the reading absorbing. We read the volume at a sitting. We turned back and reread parts with a feeling that if we could we would have the manuscript many times longer. All of us pick up a book we dread to have em. Such is Howell's little gem.

We recommend this short work because all physicians should be familiar with Medicine in Canada. We promise you will not put it aside to make a fourth at bridge or turn to the latest "best seller"; we promise many a quiet chuckle and you'll find yourself half closing your eyes and thinking of virgin wildernesses, old French names, and the romance of medicine among the pioneers in a new land.

These days layman and physician talk at great length of nutrition. Few truly know what they are talking about. In this volume Doctor Lusk, leading up to his subject, begins with The Ancient World, and then follows with The Middle Ages; The Seventeenth Century; The Eighteenth Century; Dietetics; The Nineteenth Century, French Era; The Nineteenth Century, German Era; and The Modern Phase.

Doctor Lusk shows he gave mature thought and careful choosing in this work of only 142 pages. Unfortunately, he died shortly after finishing the manuscript. Eugene F. Du Bois, Robert O. Loebel, and Dr. Lusk's secretary, Miss P. R. Schaub corrected the proof.

Former pupils of Dr. Lusk will remember his lectures for all time. Students from all over the world came to sit at his feet and be transported into another world. The lectures in this book carry that indescribable something that makes for inspired reading.

The writer of this review is not interested in the general subject of nutrition. But he revels in good authorship and when he had closed Dr. Lusk's book he felt more than repaid for an evening devoted to it.

These two books are unusual. In this age of hurry and short cuts the physician owes it to himself to know more of those who have gone before, making possible the commonplace procedures and facts of medicine of today. If you would be advised then, get in a chair and open these volumes. If you do we know you will want to go back to the first one in this set published and read them all.

BOOKS RECEIVED

All books received by The American Journal of Surgery are listed in this column as soon as possible after their receipt and this must be considered as adequate acknowledgment. Books that the Editor considers of special interest to our readers will be reviewed in a later issue.

Bluttransfusion in Theorie und Praxis (Die). By Hans Wildegans. Berlin, Springer, 1933.

Cancer du colon droit. By Jean Gosset. Paris, Masson, 1933.

Chirurgische Tuberculose. By Max Flesch-Thebesius. Dresden-Blasewitz, Steinkopff, 1933.

Disque intervertebral (Le). By G. Mauric. Paris, Masson, 1933.

Endocrine Medicine. By William Engelbach, M.D. Vol. 4, Springfield, Ill., Thomas, 1932.

Etudes neurologiques. By Georges Guillain. Ed. 5, Paris, Masson, 1933.

Gynecology for Nurses. By George Gellhorn, M.D. Ed. 2, Phila., Saunders, 1933.

Handbuch der gesamten Unfallheilkunde. By Fritz Konig and Georg Magnus. Vol. 3, Stuttgart, Enke, 1933.

History and Epidemiology of Syphilis. By Wm. Allen Pusey, M.D. Springfield, Ill., Thomas, 1933.

Human Values in Psychological Medicine. By C. P. Blacher, M.D. London, Humphrey Milford, 1933.

Intracranial Tumors. By Loyal Davis, M.D. Annals of Roentgenology, xiv. N. Y., Hoeber, 1933.

Knotenbildungen des Darms (Die). By K. E. Kallis. *Acta Chirurg. Scandinav.*, vol. 70, suppl. xxi.

Peripheral Nerve Injuries. By Lewis J. Pollock, M.D. and Loyal Davis, M.D. N. Y., Hoeber, 1933.

Principles and Practice of Obstetrics. By Joseph B. DeLee, M.D. Ed. 6, Phila., Saunders, 1933.

Röntgenraumbild (Das). By Werner Teschendorf and Hans Köhnle. Berlin, Urban und Schwarzenberg, 1933.

Sciences and Practice of Surgery (The). By W. H. C. Romanis, M.D. and Philip H. Mitchiner, M.D. 2 vols., Phila., Lea and Febiger, 1933.

Synopsis of Surgery (A). By Ernest W. Hay Groves, M.D. Ed. 10, N. Y., Wood, 1933.

Treatment of Rheumatoid Arthritis and Sciatica (The). By A. H. Douthwaite, M.D. London, Lewis, 1933.

ACUTE INTESTINAL OBSTRUCTION

MONROE A. McIVER, M.D., F.A.C.S.

NINTH INSTALLMENT

PART II: DIAGNOSIS AND TREATMENT

CONTENTS

[This Number]

Chapter		Vol. XXI Page
XXIII.	Treatment: The Operation (Cont.)	472
XXIV.	Treatment (Cont.): Points in Certain Types of Obstruction	481
XXV.	Treatment (Cont.): Care of the Patient after Operation	489
XXVI.	Treatment (Cont.) Complications	493

[Previously Issued]

PART I: THE DISEASE

		Vol. XIX
I.	Introduction	163
II.	General Considerations	172
III.	Varieties of Obstruction	191
IV.	Varieties of Obstruction (Continued): Bands and Membranes	365
V.	Varieties of Obstruction (Continued): Volvulus	378
VI.	Varieties of Obstruction (Continued): Intussusception	387
VII.	Varieties of Obstruction (Continued): Internal Hernias	581
		Vol. XX
VIII.	Varieties of Obstruction (Continued): Neoplasms	171
IX.	Varieties (Continued): Strangulated External Hernia	182
X.	Varieties (Continued): Occlusion of the Mesenteric Vessels	194
XI.	The Clinical and Pathological Picture: Morbid Anatomy	476
XII.	Clinical Pathological Picture (Continued): General Findings	483
XIII.	Clinical Pathological Picture (Cont.): Changes in Body Fluids	489
XIV.	Clinical Pathological Picture (Cont.): Mechanism of Cardinal Symptoms	500
XV.	Functional Obstructions	812
XVI.	Functional Obstructions (Continued): Varieties	823
XVII.	Functional Obstructions (Continued): Preventive Measures	833
		Vol. XXI
XVIII.	Diagnosis: General Considerations	145
XIX.	Diagnosis (Cont.): Special Points & Differential Diagnosis	159
XX.	Treatment: Preoperative	308
XXI.	Treatment (Cont.): The Operation	317
XXII.	Treatment: The Operation (Cont.)	326

Chapter XXIII

TREATMENT (Continued)

The Operation (Continued)

Enterostomy. Opening a distended segment of intestine above the point of obstruction and so establishing drainage is one of the oldest and most primitive procedures for the relief of intestinal obstruction. The fact that in selected cases the operation still has an accepted place shows upon what a sound physiological basis it rests: namely, the relief of increased intra-intestinal pressure with its resultant damage to the capillary circulation and the bowel wall.

Indications for the Use of Enterostomy. Enterostomy has a wide field of usefulness[1,2] and is employed under a number of different circumstances that may conveniently be considered in the following groups:

1. Not infrequently patients with obstruction are brought to the surgeon late in the disease, when they are desperately ill and obviously in such a condition that no extensive operation could be considered. Most of these patients will die whatever is done; but an enterostomy without exploration will occasionally effect a recovery (provided, of course, that no strangulation exists), or bring about sufficient improvement so that more extensive procedures can be carried out later.

2. Enterostomy may be used as a supplementary procedure under various conditions, as follows:

In cases where, after the obstruction has been freed, the bowel is found to be atonic, dilated, and functionally handicapped by the effects of the obstruction, it is often wise to do an enterostomy to relieve the tension and distention and allow the bowel to recover its tone.*

* In 1812 Travers, speaking of strangulated hernia, wrote:

"First, that there is a state of the intestine wanting the criteria of gangrene, in which the operation does not arrest the symptoms caused by obstruction. Secondly, that such intestine when examined after death remaining unaltered, no signs of disorganization being present, there is much reason to suppose that it has been palsied by the

Where an anastomosis has been carried out, an enterostomy above is often a factor of safety in protecting the suture line against damage from distention.

In cases where a resection has been carried out, an immediate anastomosis may for various reasons be unwise. Here, quite a different type of enterostomy is indicated: namely, the bringing of both ends of the intestine outside of the abdomen, the anastomosis being delayed for a more favorable occasion.

3. The use of enterostomy in obstructions that occur early after abdominal operations will be discussed in Chapter XXIV. In brief, it may be said that an extensive exploration or attempted lysis of newly formed inflammatory adhesions is often dangerous and unnecessary; enterostomy is frequently the only procedure indicated.[3,4]

4. The value of enterostomy in peritonitis will presently be discussed in some detail. It may be said in passing that the operation has its greatest usefulness in cases where there has been some localization of the infection, the obstructive symptoms being due to recent inflammatory adhesions and atony of those intestinal coils in immediate contact with the infected area.

Location of the Enterostomy. The location of the enterostomy must depend upon the circumstances and findings in the individual case, and upon the level of the obstruction. When the obstruction is located in the colon, a cecostomy is usually the operation of choice; when the obstruction is high in the small intestine, the enterostomy must necessarily be high; when the obstruction is low in the small intestine one can, under varying

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duration and severity of the stricture. Thirdly, that the return of a bowel unequal to the resumption of its muscular or peristaltic action, counteracts the intention and defeats the success of the operation, for though the strangulation is removed, the only dangerous consequence of it, the obstruction, continues."

Travers, quoting Bichat, says: "If we consider the paralysing effect of acute inflammation attacking a muscle; the inability of the oesophagus, the urinary bladder and other parts to obey their natural stimuli when so affected; we shall have no difficulty in accounting for the torpor of a bowel recently released from strangulation. Not only is the tissue of the organ gorged with a preternatural quantity of blood, but of blood unfitted by its stagnation for the maintenance of the vital functions." (Travers, 1812.)

circumstances, elect to make the enterostomy low, near the seat of the obstruction, or high, in the jejunum. At times the best that can be done is to utilize the first distended loop of gut presenting itself in the wound. When enterostomy is being carried out to protect an anastomosis, it had best not be placed at too great a distance above the suture line.

The older idea in regard to the best location for the enterostomy was that it should always be made in the segment of intestine just above the point of obstruction; in other words, since most of the obstructions are situated in the lower portions of the intestinal tract, it should be a low enterostomy. This was a logical view, for since drainage from a distended intestine depends upon peristaltic action, it would seem that if a vent were placed near the point where the contents are arrested, the peristalsis would continually push material out through the artificial opening.

For a number of years, however, the older dictum as to the location of the enterostomy has been questioned. In 1910 and 1916, Bonney[5,6] advocated placing the enterostomy, not low in the intestine near the point of distention, but high in the jejunum. His contention was that the segment near the obstruction usually contained gas only, while the greatest accumulation of fluid occurred in the jejunum; and that the jejunum, therefore, was the logical place to establish drainage. In 1913, McKenna[7,8] also advocated jejunostomy, under the belief that duodenal secretions were responsible for the toxemia and that a jejunostomy was the best means of draining the duodenum. Both Bonney and McKenna reported cases successfully treated by jejunostomy.

Just why a jejunostomy may be more successful than an opening nearer the point of obstruction is not altogether clear. The idea that the symptoms of obstruction are caused by a toxic secretion from the duodenal mucosa has been generally abandoned; and Bonney's idea that the coils of intestine near the obstruction contain only gas is often not borne out by observation at operation. It is true, however, that the greatest

outpouring of fluids occurs high in the intestinal tract, and that drawing this off by a jejunostomy prevents over-distention of the lower intestinal segments. Whatever the reason back of

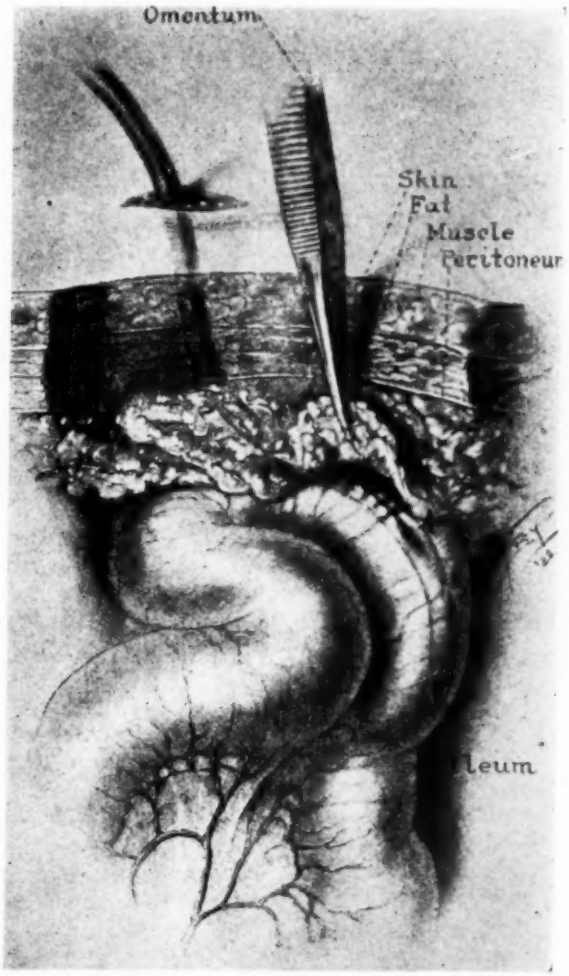

FIG. 55. Mayo's technique for catheter enterostomy. (After Mayo.[12])

it, certain cases do brilliantly with a jejunostomy;[9] it is especially useful in those cases where peritonitis plays a rôle. The use of a valvular type of enterostomy lessens one serious objection to the operation, namely, an uncontrollable loss of fluids, and also prevents the digestion of the abdominal wall

by active ferments that so often occurred with the older type of enterostomy when it was placed high in the intestinal tract.

Technique. When the opening into the small intestine is not intended to be permanent, the valvular type of enterostomy, where a catheter is employed, has largely replaced the older methods, where the opening into the intestine was sutured to the edge of the abdominal wound or a flanged glass tube was tied into the intestinal opening. The valvular enterostomy is usually performed according to the method described by Long[10] and Mayo,[11] which is based on the Witzel technique for performing a gastrostomy (Fig. 55).[12] If the loop is distended it may be desirable to empty it by inserting a needle attached to a suction apparatus. If possible, intestinal clamps should be applied before the opening for the insertion of the catheter is made, one clamp being applied first, the contents milked out of the section of bowel that is to be opened, and then a second clamp applied.[4] Placing a purse-string suture which may be drawn tightly around the catheter as soon as it is inserted is at times a useful manoeuver in preventing leakage while the bowel is being infolded around the catheter. On completion of the intestinal suture, the free end of the catheter should be passed through a small opening in the omentum; the omentum is then tucked down over the suture line and around the point where the catheter emerges from the gut wall. This is important in preventing contamination of the peritoneal cavity and in ensuring prompt closure of the enterostomy when the catheter is withdrawn. The intestine may or may not be anchored to the peritoneal edges of the abdominal wound.

When the valvular type of enterostomy has been used, prompt closure usually follows withdrawal of the catheter. When this does not take place, there are various procedures which may be employed (see p. 499 under "Complications").

When a tube is being used in performing a cecostomy, care should be taken that it is of large size, for lumps of solid material in the colonic contents readily plug a small opening.

Care of the Enterostomy. If the enterostomy is to accomplish its purpose, it is essential that satisfactory drainage take place. Fundamentally this depends upon the peristaltic action of the bowel; but constant care is required to make sure that when a tube is used no kinking or blockage of its lumen takes place. The injection and aspiration every few hours of a small quantity of salt solution will at times be found effective in maintaining drainage.

When the more acute symptoms of obstruction subside and the foul drainage ceases, normal saline or other types of nutritive solutions may advantageously be injected into the bowel through the enterostomy opening and so assist in maintaining the body fluids and general nutrition.[13]

Value of Enterostomy in Acute Peritonitis. In approaching the subject of the value of enterostomy in acute peritonitis, one should realize that the situation is complex. The peritonitis may be widespread or sharply limited. At times an abscess exists, surrounded by coils of small intestine. Acute peritonitis may affect intestinal motility in two ways: it may cause a functional disturbance through atony of the bowel; or it may produce light adhesions which interrupt the intestinal movements by kinking or twisting the bowel. Both these factors are often present.

Most cases of diffuse, acute peritonitis show some degree of functional disturbance of intestinal motility,* although at times the disease runs such a fulminating course that this aspect does not have time to assume any importance in the clinical picture; the death is then obviously one of sepsis and is comparable to death from sepsis due to the infection of any of the large serous cavities such as the pleura or the pericardium. A general atonic dilatation of the whole intestinal tract, however, often occurs (the so-called "paralytic ileus") which may result in symptoms of obstruction: abdominal distention,

* In considering a patient with peritonitis it should not be forgotten that a quiet intestine and a moderate degree of distention may possibly be advantageous in walling off or limiting the infectious process.

vomiting and obstipation. The outcome in these cases depends chiefly on the ability of the patient to overcome the infection; if that takes place, the bowel will usually resume its normal activity. (See "Functional Obstruction."*)

If, however, the course of the disease in these patients with paralytic distention be carefully observed over several days, a few cases will be noted in which, although the patient is successfully convalescent and is localizing the infection, distention and profuse vomiting continue. On auscultation, gurglings can be heard and the patient may complain of gas pains; enemas give unsatisfactory results. These symptoms point toward the development of a mechanical element in the obstruction, due to light fibrinous adhesions;† and an enterostomy is often a lifesaving procedure.[3] There are also comparable cases in which from the outset the peritoneal sepsis is to a large extent limited to the lower abdomen or pelvis and involves only those coils lying in the immediate vicinity of the inflammatory process (Handley[15]‡ and Wilkie[16]). In this type of case the symptoms of obstruction often arise during the convalescence from operations for acute appendicitis; further discussion of these cases will be found under "Early Postoperative Obstruction," page 481, where an enterostomy is recommended.

In the foregoing cases, where the peritonitis is at least partially localized and where there is a mechanical element in addition to the atony, an enterostomy undoubtedly gives excellent results. The debatable point comes in regard to the group where a diffuse peritonitis alone causes varying degrees of intestinal atony, distention and vomiting. There has been a tendency on the part of some authors[18,19] to advise an enterostomy in practically all cases of peritonitis in the belief that

* This appeared in the June installment, p. 812.

† Wilkie has shown experimentally that this type of adhesion is quite capable of producing obstruction.[14]

‡ Handley[15] and Anspach[17] have advised sidetracking the intestinal stream around inflamed, atonic coils by an anastomosis of the small intestine above the point of involvement to the colon below.

a high percentage of patients die not from peritoneal sepsis but from a secondary, functional obstruction. The soundness of this view is open to question. Certainly an enterostomy performed on a patient dying of toxic absorption from an infected peritoneum is a futile gesture which can only hasten the end. Also, if the whole bowel is atonic, it is unreasonable to expect that satisfactory drainage from the enterostomy tube will take place in the absence of the propulsive force of peristalsis.

As a practical matter of fact it must be admitted that it is often difficult, clinically, to pick out the case with peritonitis that will benefit by enterostomy. If the distention is pronounced and does not yield to simple methods such as poultices and rectal tube, and if vomiting is profuse, an enterostomy done under local anesthesia is at times justified and should not be delayed until the patient is moribund. In the presence, however, of an advancing, fulminating peritonitis, and in the absence of any sign of peristaltic action (cramp-like pains, audible or visible peristalsis), the results will often be disappointing; and in certain of these cases perhaps as much can be accomplished by means of a small Levine tube inserted into the stomach through the nares, as by an enterostomy.

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Chapter XXIV

TREATMENT (Continued)

Points in the Treatment of Certain Types of Obstruction

Early Postoperative Obstruction. The type of operative procedure to be selected for the relief of early postoperative obstruction depends, obviously, upon the general condition of the patient and the findings within the abdominal cavity at the time of operation. Certain broad principles, however, may be applied. Since these obstructions for the most part depend upon recently formed adhesions, usually accompanied by a certain amount of functional atony, if the bowel can be adequately drained, the peristalsis above the point of obstruction will be quieted and the propulsion of more material into the obstructed segment prevented. The secondary changes in the bowel wall resulting from distention will also be prevented. Frequently a catheter drainage above the obstruction is all that is required; and this can, of course, be carried out under local anesthesia without a thorough exploration, which is of great advantage in a very sick patient. Symptoms of obstruction may subside after such a drainage operation, the light adhesions being absorbed and the bowel regaining its tone without further procedures. How much exploration is required is a matter for the operator to decide: it depends upon a number of factors, particularly upon the condition of the patient and the presence or absence of acute peritonitis.

Interference with the mesenteric circulation is rare in these cases; thus if no bloody peritoneal fluid is found it is presumptive evidence that strangulation is not present; when it does occur, a rising white blood count may indicate its presence.

As already stated, it is dangerous to attempt to separate a mass of inflammatory adhesions: the bowel is exceedingly friable and is likely to tear; and since its contents are highly infectious, if such an accident does occur it is likely to be

followed by a fatal peritonitis. There is also the danger that in an attempt to free an involved segment of bowel, a localized area of infection may be opened with a resulting spread of the peritonitis.

Occasionally a volvulus may be present or herniation through some internal opening may have occurred.[1] While these types of obstruction are rare in the early postoperative group, the operator should bear in mind the fact that they are at times encountered. Volvulus occurred postoperatively in 3 instances in the 1918–1927 Massachusetts General Hospital series. In one case a jejunostomy was performed without exploration; the symptoms were not relieved, and a later exploratory operation revealed the twist; the patient died. The two other postoperative volvuli were discovered and relieved at exploration; these patients recovered.

The operations carried out in the remaining 37 cases of early postoperative obstruction at the Massachusetts General Hospital were as follows:

	CASES	DEATHS
Enterostomy alone	17	9
Enterostomy with lysis of adhesions	10	5
Entero-enterostomy with lysis of adhesions	1	0
Lysis of adhesions alone	9	3
Total	37	17

Obstruction from Intussusceptions. The operation for intussusception, in cases received early, is one of the easiest in surgery, namely, reduction of the intussusception by taxis. The invaginated bowel should be "milked" out, not pulled out; occasionally slight traction is necessary to remove the last portion of ileum from the cecum. After reduction of the intussusception, the bowel should be carefully palpated to see if a polyp or diverticulum or tumor can be felt; these structures are not infrequently responsible for enteric intussusceptions, and may cause recurrences.[2]

The difficulties are encountered in the later cases, where reduction is impossible, due to edema and swelling, or where

the various layers are glued together by inflammatory adhesions. In Bolling's[3] experience most of the difficulties in reduction encountered in his operative series were due to swelling and edema rather than to adhesions. These irreducible intussusceptions, frequently gangrenous, may be dealt with in a number of ways; but all ways show a high mortality. The simplest and most direct method is a resection of the intussusception, followed by immediate or delayed anastomosis. This is particularly applicable to adults with enteric intussusception, a rather rare variety. In the ileocecal and ileocolic varieties this procedure is too formidable, especially in children, in whom these types of intussusception usually occur. It must be emphasized that any extensive procedure in a young child is almost certain to be fatal. The method advocated by Coffey,[4] namely, resection of the intussusception after an incision in the outer layer, is a radical procedure and involves contamination with the septic bowel contents. This latter objection applies also to Brown's[5] suggestion that an incision be made into the cecum, freeing the constricted neck of the intussusception.*

A method recently suggested by Montgomery and Mussil[6] would seem to have possibilities: these authors advise taking advantage of Nature's method of occasionally effecting a spontaneous cure,† and propose merely fixing the intussusception in place by interrupted sutures at the neck, then making an anastomosis between the ileum and the colon, distal to the intussusception. The intussusception presumably sloughs off into the intestine; in their cases it caused no further symptoms. They report 2 cases in which operation was successfully carried out by this method. Another operation was suggested by Codman[7] in 1908 for use in irreducible cases in which the small intestine was invaginated into the large intestine. This consists essentially in ligating and dividing the impacted mesentery close to the neck of the intussusception, dividing the

* Brown and Coffey reported only one case each.

† See February installment, p. 399.

bowel between clamps and bringing the ends out of the abdominal wound; after a few days, when the intussusceptum has become gangrenous, it can be drawn out of the intussuscipiens

FIG. 56. First stage of Mikulicz operation for volvulus of a sigmoid megacolon. (After Weeks.[10])

by gentle traction. The procedure was advocated particularly for desperate cases, to replace resection and hopeless efforts at reduction.

Either of the two foregoing methods seems better than merely doing an enterostomy in irreducible cases that are not suitable for resection. Enterostomies are usually of little value in any case, and are of none when the intussusception is not reduced.[8] Occasionally a life may be saved by drawing the intussusception out onto the abdominal wall and doing an enterostomy in the distal end of the gut.

Obstruction by Volvulus. The extent of the operation for volvulus of the small intestine depends upon the pathological condition found at operation; untwisting of the loop and division of any bands and adhesions may be all that is required. If the circulation has been so damaged that the bowel is not viable, resection must be carried out or the bowel must be extraperitonealized.

In volvulus of the sigmoid, where the bowel is viable the question of recurrence of the twist must receive consideration. Deaver[9] has advised a lateral anastomosis between the proximal and the distal limbs of the loop, with later resection of the loop if the volvulus recurs. Where the twisted loop of sigmoid is not viable, it had best be drawn out of the wound and a Mikulicz type of resection carried out. (See illustration of Weeks'[10] case showing resection by the Mikulicz method in volvulus of a sigmoid megacolon; Fig. 56). It may be well to perform a cecostomy as part of the first operation. Bloodgood[11] stresses the importance of the careful division of adhesions and of covering the raw surfaces with peritoneum as a prophylaxis against recurrence. It is often a useful procedure to pass a tube upward through the rectum and draw off the contents of the loop after the sigmoid has been untwisted.

In volvulus of the cecum, a cecostomy should usually form part of the operation: it not only drains the obstructed loop, but anchors the cecum so that recurrences are not likely.[12]

Obstruction from Mesenteric Thrombosis or Embolism. The patient with obstruction from mesenteric thrombosis or embolism is often desperately ill; and local anesthesia is desirable. The operative procedure usually consists of resection of gangrenous intestine, with or without immediate anastomosis. In the more desperate cases, the gangrenous intestine may be drawn outside the peritoneal cavity and the wound closed around its mesentery. Extremely rarely, recovery takes place without resection,[13,14] for occlusion of a mesenteric vessel is not always followed by infarction: the collateral circula-

tion may be sufficient to maintain the blood supply to the bowel. In a case of this type reported by Ross,[14] an exploratory operation was performed; after inspection of the involved loop, it was decided that the circulation was sufficient to prevent necrosis; no further procedures were carried out, and the patient recovered.

Obstruction by Neoplasm. It is now well established that operative procedures upon cases of acute obstruction of the large intestine by neoplasms should be directed toward draining the bowel above the point of obstruction, usually by a colostomy or a cecostomy, without any attempt at a direct attack upon the tumor. This procedure can usually be carried out satisfactorily under local anesthesia. It is wise to wait for from ten days to two weeks after this first operation, so that all symptoms of obstruction may subside and the bowel regain its normal tone, before attempting a radical operation upon the neoplasm. Occasionally it will be possible in obstructions of the cecum or ascending colon to carry out, as a first stage operation, a lateral anastomosis between the ileum and the transverse colon, diverting the intestinal stream around the point of obstruction. A supplementary ileostomy may be indicated.

In obstructions from metastatic carcinomas, only palliative procedures, of course, are to be considered. These might consist either of simple drainage above the point of obstruction, or of some type of anastomosis sidetracking the intestinal stream around the point of obstruction.

In the rare cases in which a primary tumor obstructs the small intestine, it is usually possible to excise the growth at the first operation. The continuity of the intestinal tract may be re-established at the same time or later, at the discretion of the operator.

Obstruction by Strangulated External Hernias. For strangulated external hernias, local or spinal anesthesia is usually the anesthetic of choice; although if the case is seen early a general anesthetic is frequently safe.

In the uncomplicated cases, all that is required in the way of operative procedures is exposure and opening of the sac, cutting of the constricting ring, followed by reduction of the hernia and repair of the defect. In the cases where the intestine is found to be gangrenous, it must be resected. Following this, immediate anastomosis may be carried out, or the ends of the intestine may be brought outside the wound and anastomosis reserved for a secondary operation: the decision as to which procedure is preferable in the individual case, and as to what extent the operation may be justifiably prolonged, must rest on the judgment of the surgeon. In the Richter type of hernia, where a portion of the bowel wall alone may be necrotic, the area of necrosis may be infolded without resort to resection. Where resection is carried out, a temporary enterostomy above the anastomosis is frequently desirable.

Table XIV shows the operative procedures and mortality in 19 cases of strangulated external hernia where necrosis of the bowel was found at operation.

TABLE XV

OPERATIVE PROCEDURES AND MORTALITY IN 19 CASES OF STRANGULATED EXTERNAL HERNIA WHERE NECROSIS OF THE BOWEL WAS FOUND AT OPERATION (MCIVER[15])

Type of Operation	*Number of Cases*	*Number of Deaths*	*Mortality*
Resection, ends brought out	7	5	71 per cent
Loop of questionable viability brought outside peritoneum	1	0	0
Resection, immediate anastomosis	8	5	62 per cent
Inversion of necrotic area and enterostomy 8 inches above repair	1	1	100 per cent
Small necrotic area perforated; catheter placed in opening	1	0	0
Inversion of small necrotic area	1	0	0
Total	19	11	58 per cent

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Chapter XXV

TREATMENT (Continued)

Care of the Patient after Operation

When ether has been used as the anesthetic for the operation, the patient should be carefully watched during the recovery stage to guard against the aspiration of vomitus.

As already stated, maintenance of the body temperature, both in the operating room and after returning to the ward, is extremely important. The frequent pulse and blood-pressure records that have presumably been taken during the operation should be continued on the ward until the danger of "operative shock" is past.

Administration of Fluids. Everything that was said in the chapter on preoperative care of the patient, in regard to combating dehydration by the administration of salt solution, applies with equal force to the treatment after operation. In the more serious cases, the normal saline solution may be administered subcutaneously, intravenously and by rectum. When the body has been seriously depleted of water and the essential sodium and chloride ions, it is important that this loss be corrected as soon as possible. Glucose may be given in the salt solution if it seems desirable; but it is the latter solution that is essential. As to the amount of salt solution to be administered, no didactic rules can be laid down: it depends upon the extent of the dehydration when treatment is started, and upon the daily output of fluids. One should take into account the clinical evidence of dehydration and correlate this with the laboratory findings; in the severe cases, 4 to 6 liters may not be too much in the course of twenty-four hours; the milder cases will naturally require much less. When intravenous injections are being made, care should of course be taken to give the fluid slowly, in order not to embarrass the circulation. Where the fluid is being given subcutaneously, there is no object in giving more than can be efficiently absorbed. In

TABLE XVI

Day post op.	*Output*				*Intake*		*Remarks*
	Vomitus (c.c.)	*NaCl (gm.)*	*Urine (c.c.)*	*NaCl (gm.)*	*Fluid (c.c.)*	*NaCl (gm.)*	
3rd	3500	25.2	No record	No record	5000	27	Plasma chlorides 503 NPN 57
4th	3600	25.9	No record	No record	5000	27	Plasma chlorides 440
5th	700	4.5	No record	0	5000	45	Patient being treated by small stomach tube
6th	No record	No record	No record	No record	5000	45	
7th	600	3.7	No record	0	4000	36	Plasma chlorides 500
8th	4166	26.9	310	.6	2500	18	Plasma chlorides 560
Jejunostomy	*Intestinal Drainage (c.c.)*						
9th	2240	15.96	520	3.25	4420	39.7	Marked clinical improvement. No vomiting
10th	2700	19.2	550	1.48	3160	24.3	Plasma chlorides 595
11th	4500	28.0	250	4.5	5315	34.3	Taking a small amount of fluid by mouth
12th	3400	18.5	400	2.3	2600	19	Plasma chlorides 630
13th	5800	13.3	590	2.0	4000	10	
15th	1100	7.5	No record	No record	3515	10?	Taking semi-solid food
17th Enterostomy tube removed							Bowels moving normally

Case No. 279896. M. G. H.[3] Intestinal obstruction following appendectomy with drainage for acute appendicitis. The appendix was ruptured. Second operation (8th day after appendectomy): jejunostomy. Enterostomy tube removed on ninth day after

patients receiving large volumes of salt solution over a period of several days, the kidney function should be watched and if any signs of edema of the extremities or dependent parts are noted, the volume should be reduced.

A careful chart should be kept of the intake (by all routes) and output of fluid, the latter including a record of both vomitus and urine. The keeping of this chart in twenty-four-hour periods is a simple matter and the record furnishes valuable data for use in determining the degree of dehydration and in planning further treatment. A low volume of urine is usually conclusive evidence that the patient is not receiving sufficient fluid. When a high enterostomy has been carried out, the amount of drainage in the course of twenty-four hours may be surprisingly large (an amount greater than 5 liters has been reported; see Table XVI) and of course demands adequate replacement. In adding up the total fluid output for a twenty-four-hour period one should not forget that considerable quantities are lost by evaporation from the skin and lungs; the amount is particularly large (sometimes as much as 2 or 3 liters) in patients who are sweating, and should receive consideration in an estimate of the quantity of fluid to be replaced. The importance of loss of fluid in this way has been stressed in a recent article by Coller and Maddock.[1]

The administration of fluids by mouth should in all but the simplest cases be carried out with caution, in order to be certain that the intestine has regained its tone. For a number of hours after the operation it may be wise to withhold fluid by mouth entirely, except for wetting of the mouth and throat for relief of thirst, and then to give only a few sips of water at a time until it is certain that it will be tolerated. When it is evident that the patient is able to assimilate water, other liquids may be added. Milk should be withheld for a number of days: it produces a bulky residue and tends to cause distention.

jejunostomy; bowels moving normally. This case illustrates the large amount of fluid and sodium chloride that may be lost in the vomitus and intestinal drainage. It emphasizes the fact that large quantities of fluid containing sodium chloride may be needed for adequate replacement. (Studies in this case carried out by Dr. J. C. White.)

Blood Chemistry. Blood samples should be taken for estimation of the chlorides. It is helpful also to have carbon dioxide determinations to indicate the presence of alkalosis or acidosis; and hematocrit readings may be of use in showing the extent of water loss from the plasma. The non-protein nitrogen determinations should also be made. The blood chloride and non-protein nitrogen measurements are usually of the most practical importance, furnishing as they do some indication as to the extent of the loss of chlorides and the degree of the dehydration; but as has already been pointed out, since the total volume of body fluid is reduced in dehydration, the measurements of the plasma chlorides do not indicate accurately the extent of their loss from the body.*

Drugs. There are no drugs which are especially indicated during the convalescence. During the first twenty-four to forty-eight hours after operation there is no contraindication to the use of morphine for relief of the pain incident to the operation, and it may be of benefit in increasing intestinal tone and in combatting distention.†

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* See May installment, p. 496.
† See June installment, p. 835.

Chapter XXVI

TREATMENT (Continued)

Complications

Any of the complications associated with laparotomies may occur in connection with operations for obstruction. There are, however, certain ones that are peculiar to intestinal obstruction or have special importance in relation to it, which will now be taken up. A number of these have already been discussed, but will be mentioned again for the sake of completeness.

The complications may conveniently be divided into those that occur at operation and those that manifest themselves postoperatively.

Complications of the Operation. *Anesthesia.* The complications from anesthesia have already been discussed.*

Shock. Shock is most frequently encountered following operative procedures and anesthesia, or as a terminal manifestation in the untreated disease. The symptom complex is characterized by grayish pallor, cold extremities, sweating, and a rapid pulse rate accompanied by a low systemic blood pressure. The type of anesthesia, length of operation and amount of manipulation of the intestines, particularly evisceration or traction on the mesentery, are factors of importance in its production. The escape (as the result of operative accident) of any of the highly septic intestinal contents into the abdomen introduces the element of fulminating peritonitis; and, as is known from experience gained during the World War, infection may at times be the predominating factor in the onset of shock.[1]

Aside from the complication of infection, why are patients with intestinal obstruction so prone to develop shock following operation? The answer must be that when the disease is well established, the adjustments that have occurred in order to

* See August installment, p. 311.

maintain the systemic blood pressure are taxed to their limit and the margin of safety is small. Once the compensation is broken, the collapse is likely to be rapid and irreversible. Patients with intestinal obstruction resemble in many respects those who come to operation following trauma, with a loss of blood that is significant but not sufficient to lower the systemic blood pressure: it is well known both clinically and experimentally that the further loss of even a relatively small amount of blood, or at times even brief operative procedures or anesthesia, may throw the patient into a severe state of shock.

The close analogy between patients with intestinal obstruction who develop shock following operation and patients who develop shock following hemorrhage and trauma is probably due to similarity in the underlying conditions. It is well established that a low blood volume is one of the most constant and fundamental findings in traumatic shock and hemorrhage.[2] In intestinal obstruction, the following factors tend to lower the blood volume. First, there is the great outpouring into the intestines of fluid and inorganic constituents of the digestive juices,* which are to a large extent lost in the vomitus. Second, in addition to this direct loss of fluid, the puddling of blood in the splanchnic area is often considerable: the blood vessels of the intestine above the obstruction are usually found, at operation, to be engorged, while cyanosis often furnishes direct evidence of capillary stasis. Third, in infarctions from venous occlusions, in addition to the stagnation of blood in the vessels, extravasation into the bowel wall and intestinal lumen takes place; there is also usually considerable accumulation of bloody fluid in the peritoneal cavity.

In an estimation of the significance of these vascular changes in the splanchnic area, the experiments of Erlanger and co-workers[3] and of Beard and Blalock[4] are helpful. Severe degrees of shock were produced in their experimental animals

* It has already been pointed out that this may equal two or three times the initial plasma volume of the animal. The replacement takes place from the interstitial tissue fluids and probably taxes to the limit this source of fluid.

by various types of procedure causing direct injury to the abdominal viscera (usually by exposure and manipulation of the intestines). Erlanger and his co-workers[3] also studied shock following occlusions of the inferior vena cava and the aorta. In shock produced by manipulation of the intestines, these authors consistently found great engorgement of the splanchnic area, the capillaries and venules of intestinal villi being distended and packed with red corpuscles; a considerable loss of fluid from the bowel as a result of transudation was also noted. They considered these findings of sufficient magnitude to account for the reduction of the effective blood volume to a point where failure of the circulation occurred. On this subject see also the work of Mann[5] and Wiggers.[6]

It seems reasonable to suppose that the mechanism of shock under the foregoing experimental conditions has many points in common with the shock developing in connection with intestinal obstruction.

Another element in the production of shock in cases of intestinal obstruction must be considered, direct proof of which is lacking, but in favor of which many plausible arguments may be advanced. This theory assumes that some toxic substance is absorbed from the obstructed bowel (see Part III), which causes, among other systemic effects, dilatation and increased permeability of the capillaries, with a resultant lowering of the blood volume.

Whatever the exact mechanism of shock (and there seems good evidence for believing that a number of different factors enter into the situation), it is probable that a reduction of blood volume is fundamental. This conception has direct practical importance in relation to treatment: it implies that efforts should be directed toward restoring the normal volume of circulating fluid as rapidly and efficiently as possible.

The factor of anesthesia in shock has already been discussed.

Errors of Technique or Judgment. One of the most serious errors of technique that can occur is contamination of the peritoneal cavity with intestinal contents. Normally the con-

tents of the upper small intestine are relatively sterile; but an obstructed intestine at any level contains a virulent, mixed bacterial flora which is highly septic; and a rapidly fatal peritonitis usually follows any soiling of the peritoneal cavity with this material. This accident, as shown by autopsy records, is responsible for many deaths in patients operated upon for obstruction. One of the common ways in which contamination occurs is by perforation or tearing of the gut during manipulation. The attempt to separate adhesions attached to friable, inflamed bowel is a dangerous procedure. Contamination while an enterostomy is being carried out or when the gut is punctured for any cause, is to be carefully guarded against: the intestinal loop should always be carefully walled off by gauze sponges before being punctured, so that the extent of the contamination is limited if any untoward accident occurs.

The difficulties in arriving at a decision concerning the viability of the gut in certain borderline cases where the mesenteric circulation is damaged have already been discussed.* The following case, quoted from Eisberg,[7] illustrates the results of a wrong decision:

CASE XXXV. *Illustrating mistake as to viability of bowel* (Eisberg).

S. N. 9. Male, aged sixty-four. Type of obstruction: strangulated right femoral hernia. Pathology found at operation and operative treatment: hernial sac contained several cubic centimeters of serosanguineous fluid and 20 cm. of black gut with strangulated omentum. Omentum resected. Luster and color returned to segment after application of hot pads sufficiently to warrant its replacement. Postoperative course: patient died four days after operation with signs of paralytic ileus. Wound inspection: gangrenous segment of gut found.

Remarks: viability of the gut questionable, resection considered. Circulation apparently returned but subsequently became impaired, resulting in gangrene of the segment.

COMPLICATIONS OF CONVALESCENCE. *Pulmonary Complications.* Pulmonary complications are not uncommon after operations for obstruction. The patient is frequently in a weak and debilitated condition, and pneumonia, usually of the

* See August installment, Chap. XXII.

bronchial type, not infrequently arises during the early postoperative period. Occasionally it is caused by the aspiration of vomitus. Pulmonary embolism is one of the rarer complications; it more commonly occurs after strangulations than in other types of obstruction.

Tetanus. Rarely, cases of tetanus have been reported as complicating the convalescence from operations for acute intestinal obstruction and from other operations on the intestinal tract. This is a very unusual complication, which is somewhat surprising considering how frequently the B. tetani are found in the intestinal canal under normal conditions.[8,9]

Persistence or Recurrence of Symptoms of Obstruction. Gastrointestinal symptoms should clear up rapidly after a successful operation; if they do not, there may be several explanations. Of course, a certain amount of distention and pain is associated with most laparotomies; the importance of the symptoms depends upon their severity and the underlying cause, which must be determined if possible. Recurrence or persistence of serious distention, vomiting and pain may mean that the true cause of the obstruction was not found at operation or was not adequately dealt with: for example, many adhesions may have been present and a wrong decision made as to which ones were responsible for the obstruction; or some twist of the intestine may have been overlooked. It is also true at times that even though the mechanical obstruction has been relieved, the intestine has been so injured by fatigue and distention that there is no return of peristalsis. In other words, a functional obstruction has been superimposed on a mechanical obstruction. If an enterostomy was not included as part of the first operation in these cases, it may be performed now, although it is not always successful in relieving the symptoms. The recurrence of symptoms may, on the other hand, indicate the onset of peritonitis, uremia or some other complication.

Expectant treatment consists in keeping the stomach empty and, if necessary, maintaining constant drainage by use of a

small stomach tube. A rectal tube and hot applications on the abdomen may be used in combatting distention. If hiccoughing occurs, the administration of carbon dioxide may be found helpful in relieving this distressing condition.

Occasionally the obstruction recurs after operation: the return of vomiting and pain after a period of relief is suggestive of this diagnosis. Visible peristalsis may occasionally be seen. If the symptoms do not subside promptly under appropriate treatment, the patient should be operated upon again.

Intestinal Fistulas. A fistula may arise from some localized damage to the intestine, as a result of faulty anastomosis, or following various types of enterostomy. It may be deliberately planned, as, for example, when two ends of gut are brought out through the abdominal wound after resection of a damaged segment of intestine. The introduction of the valvular type of enterostomy with the use of a catheter has greatly lessened the number of persistent or troublesome fistulas in cases of obstruction. Articles by Cameron[10] and Eliot[11] furnish interesting data on the general pathology and incidence of intestinal fistulas.

The seriousness of a fistula depends largely upon its locaton: the higher it is in the intestinal tract, the more serious a menace to life it constitutes. In general, a fistula situated low in the small intestine is very well tolerated, for adequate absorption can take place above. Of course an opening in the colon is usually quite compatible with an active life.

Children tolerate intestinal fistulas poorly, and when it is necessary to establish one in a child it should be closed early.

When a fistula is unusually slow in closing, the possibility of obstruction below that point should be kept in mind; this general surgical principle applies to the intestinal tube as well as to the ureters or bile ducts.

Local Manifestations of Fistulas. An intestinal fistula may produce both local and general manifestations. The local changes produced by the escape of intestinal contents may vary from a slight irritation of the skin, in the case of a low fistula,

to extremely rapid and serious digestion of the abdominal wall, in the case of a fistula located in the duodenum or upper jejunum. This action is of course brought about by the digestive juices.

Methods of prevention and treatment are somewhat varied. In the first place, one should avoid if possible the establishment of a high fistula.* In order to do this it is worth while, when gangrenous gut must be resected, to take some risk and perform an immediate rather than a delayed anastomosis. If a high fistula does exist, an early operative closure is sometimes indicated; while at other times simpler methods of dealing with the situation may be tried first.

Various methods have been advocated to bring about partial or temporary closure of the opening in the intestine. A T-shaped rubber tube[11] may be inserted in the gut through the fistula, serving to conduct the intestinal contents into the lower gut. An ingenious button that can be held against the internal opening has been described by Dowd.[12] When the ends of the gut have been brought outside of the abdominal wound, glass tubes, connected by a rubber tube, may be tied into the ends of the gut and the intestinal contents conducted from the upper to the lower segment of bowel[13] (see Fig. 53).† Where none of these methods is practical, it is often desirable to use a constant suction apparatus[10,14] so that the irritating secretions may be removed before they can attack the tissues. In addition to suction, Potter[15] has found effective the prone position with the patient supported on a Bradford frame. Various ointments have been applied to coat over and protect the tissues from the digestive action. Among the older ones is zinc oxide, which is still useful at times; and more recently, a paste of kaolin and glycerine has been advocated,[16] its efficacy depending on the fact that kaolin is capable of absorbing enzymes in considerable amounts. Potter[17,18] has advocated applications of beef juice with hydrochloric acid; Warshaw and

* The danger is not great from a valvular jejunostomy.

† This illustration appeared in the August installment, p. 322.

Hoffman[19] have modified this method, using continuous irrigations with peptone solution and acid. Other protein substances, notably dried milk,[20] have been advised for use in neutralizing the action of the enzymes. Cunningham[21] has suggested protecting the skin edges with copper bronzing powder. Baker's[22] article on the repair of intestinal fistulas carries many interesting illustrations of various types of operative procedure that may be used in dealing with this condition.

General Effects of Intestinal Fistulas. There are a number of ways in which an intestinal fistula may affect the general health of the patient. In certain cases, severe malnutrition may develop, due to loss through the fistula of the products of digestion before assimilation can take place. Even more important and serious in the case of fistulas located in the duodenum and upper jejunum is the loss of the digestive secretions and the sodium and chloride ions which they contain. The loss of these substances results in rapid and extensive dehydration and changes in the normal acid-base balance of the plasma; and if the changes are not corrected by proper treatment, death will follow within a few days. The situation is closely comparable to that found in simple high obstruction of the intestine, where the loss of these secretions takes place by vomiting instead of through a fistula; the end result is the same in both cases.* This similarity between high intestinal

* Extensive experimental work has been done on different types of high intestinal fistulas. In some of these experiments the total intestinal stream has been diverted to the surface; in others the various digestive secretions have been diverted to the surface one at a time in order to study the effects of their loss. Four important digestive secretions are poured into the duodenum: gastric juice, pancreatic juice, bile, and intestinal juice. The loss of the first two is the more serious, and in untreated animals produces death. The loss of either alone produces characteristic changes in the chemistry of the blood and body fluids.

Some of the earliest work was carried out by Pawlow,[23] who observed that dogs with pancreatic fistulas died unless they received appropriate treatment. More recently, studies on the fatal effect of the loss of pancreatic juice have been carried out by Elman and McCaughan,[24] Walters and Bollman,[25] and Gamble and McIver.[26,27] The last-named investigators, after collecting and analyzing the various digestive secretions, sought to correlate the results with the changes in the blood and body fluids produced by the loss of the several secretions. Walters et al. showed by an ingenious series of operations that the loss of the pancreatic secretion caused death but the loss of bile or the secretion of

obstruction and high intestinal fistulas has recently been emphasized by Morton.[30] The treatment consists in the administration of normal salt solution in quantities sufficient to counteract the loss from the fistula. It is essential that this treatment be started early, for it is much easier to maintain the patient in a normal state than to restore him to such a state after extensive dehydration has taken place.

As has already been suggested, very satisfactory results may often be obtained by collecting the secretions from the fistula and re-injecting them into the distal segment of the bowel.

In summary, it may be said that the management of an intestinal fistula includes treatment instituted to protect the tissues from irritation and destruction by the digestive enzymes; and general measures of combatting dehydration and other changes in the body fluids that result from the loss of the digestive secretions.

Complications Resulting from Extensive Intestinal Resection or Exclusions by Short-circuiting Operations. It is not infrequently necessary to remove a considerable portion of the small intestine because of gangrene or other conditions. Or, extensive sections of the intestinal tract may be excluded by short-circuiting operations. Due to the body's power of adaptation, if a proper dietary régime is carried out these abnormal conditions are often borne surprisingly well. In general, this régime

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the duodenal mucosa did not. Walters and Bollman[28] also studied the effects of a gastric fistula, and found that it resulted in a chain of events similar to pyloric obstruction, where the gastric secretions are lost in the vomitus. The work may be summarized as follows:

A duodenal fistula diverting the combined secretions to the surface is rapidly fatal, the animal showing severe dehydration, low blood chlorides, usually an alkalosis, a high urea nitrogen and a lowering of fixed base. When the gastric secretion alone is lost the same picture is produced, except that the alkalosis is more marked and tetany often occurs. The loss of the pancreatic secretion alone is likewise rapidly fatal: the dehydration is extreme; the lowering of fixed base is greater than when the gastric secretion alone is lost; and instead of an alkalosis an acidosis may occur. The loss of the bile and secretion of the duodenal mucosa is not fatal (in acute experiments) and, as might be predicted from a study of their chemical composition, does not produce marked changes in the composition of the blood plasma.[25,29]

consists of a diet rich in carbohydrates, poor in fats and containing only a moderate amount of protein.

One of the most extensive and comprehensive studies of this subject was made by Flint,[31] who studied the effects both of resections and of short-circuiting operations. This investigator showed that, in dogs, 50 per cent of the total small intestine might be removed and the animal, when kept on a favorable diet, return to normal condition; where 75 per cent or more had been resected, the animal might survive but was not likely to show a complete recovery. At first the animals showed severe diarrhea, thirst and hunger, with loss of weight; later they were able to establish a balance and return to more normal condition, the compensating processes in the intestines consisting of a hypertrophy and hyperplasia of the remaining portion of the small intestine: there was a marked increase in the transverse diameter of the gut, and the villi and crypts were increased to almost twice their original size.*

The metabolic studies showed at first an increased excretion of fat, carbohydrate and nitrogen; later, carbohydrate was absorbed to a degree considerably above normal. There were indications of extensive putrefaction in the colon. From a study of clinical material, this author concluded that, in general, human cases behaved like the animals he had studied. Palmer,[35] after careful metabolic studies on a patient who had undergone resection of the lower half of the small intestine for tuberculous ulceration and stricture,† found that the loss of nitrogen in the stools was four or five times that of the normal individual; while the loss of fat was five to six times the normal amount. There was also a high urinary indican.

The length of small intestine that may be removed in human cases without fatal results shows considerable variation.

* In connection with experimental resections of the intestines, total extirpation of the duodenum should be mentioned. According to an old theory, the duodenal mucosa formed a secretion that was necessary for life or for the normal functioning of the lower intestinal segments. That such was not the case was shown conclusively by Dragstedt, Dragstedt and Chase,[32] Grey,[33] and Moorhead and Landes,[34] who successfully removed the total duodenum without ill effects to the animal.

† It is interesting that at one time after operation, the patient developed tetany.

Doerfler[36] reported resection of all of the small intestine except 12 cm. at the jejunal end and 20 cm. at the terminal ileum. Recently, Jerauld and Washburn[37] reported the removal of 579 cm. (19 feet) of small intestine, the patient recovering from this operation and surviving a second operation for acute obstruction.

While even extensive resections are often surprisingly well borne, severe symptoms of malnutrition may arise; so that a guarded prognosis should be given especially where considerable lengths of small intestine have been removed. Certain mechanical complications following exclusion operations have already been discussed.

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AUTHOR INDEX TO VOLUME XXI

Albee, Fred H., 204
Allen, Edgar V., 72
Anderson, Forrest N., 210

Berlin, David D., 173
Binkley, George E., 78
Burden, Verne G., 235
Butler, C. S., 466

Campbell, Meredith F., 85, 452
Case, James T., 463
Coombs, James N., 428
Cooper, William M., 408
Crile, G. W., 82

Delaney, W. Eugene, Jr., 403

Eisenberg, Arthur A., 56, 180
Eiss, Stanley, 97

Farmer, Vincent, 116
Feldman, Maurice, 376
Fine, Jacob, 184
Flothow, Paul G., 345
Forrester, C. R. G., 230

Gatewood, 28
Gerendasy, Julius, 12
Gillespie, M. G., 30
Glaser, Mark Albert, 210
Goldish, D. R., 30

Haines, Charles Everett, 297
Hall, George Joyce, 272
Hauswirth, Louis, 180
Hawley, George W., 302
Hill, Luther L, Jr., 247

Illievitz, A. B., 21

Jones, Howard, 406

Kellogg, Edward L., 368
Kellogg, William A., 368
Kretchmar, Arthur H., 383

LeFever, H. E., 431
Levenson, Walter S., 184
Lifvendahl, R. A., 123
Long, Edgar C., 43

McCaughan, John M., 126
McClintock, J. C., 82
McIlroy, P. T., 297
McIver, Monroe A., 143, 307, 471
McKeown, Raymond M., 242
Macklin, Madge Thurlow, 438
McQuiston, J. Stuart, 72
MacRae, J. Donald, 454
Martin, J. D., 17
Means, Hugh J., 431
Metcalfe, Raymond F., 294
Meyer, Karl A., 1
Moorhead, John J., 127

Nemens, Harry S., 56
Norburn, Charles S., 454

O'Connor, Denis S., 227
Ottenheimer, Edward J., 120

Parsons, W. H., 458
Perkins, Orman C., 104
Phillips, John R., 38

Rabinowitz, Harold M., 260
Rees, Clarence E., 411
Riba, L. W., 418
Rosenfeld, Samuel S., 279

Salsbury, C. Russell, 354
Saltzstein, Harry C., 358
Sarma, P. J., 390
Shawan, Harold K., 43
Singer, Harry A., 1, 392
Snoke, Paul O., 111
Stanton, E. MacD., 461
Stepita, C. Travers, 450
Strode, J. E., 240
Swift, George W., 345

Taylor, Frederic W., 131
Taylor, K. P. A., 285
Thompson, Gershom J., 421
Thompson, James E., 214
Tomaiuoli, Michele, 289

Vaughan, Roger T., 392
Vermooten, Vincent, 242]
Vernon, S., 416

Wallerstein, Harry, 180
Warnock, Fanny Bell, 47
Welton, Thurston Scott, 130, 299, 301, 465
Wendel, August, 446
Weston, W. G., 458
Whitman, Royal, 335
Wright, Thew, 397

SUBJECT INDEX TO VOLUME XXI

(B.B.) = Bookshelf Browsing; (Bi.B.) = Biographical Brevities; (C.R.) = Case Reports; (E.) = Editorial; (N.I.) = New Instruments

Abdomen, penetrating wounds of, 17
Abduction method, 335
Abruptio placentae, management of, 279
Agenitalism, hereditary, 104
Angina pectoris and congestive heart failure, therapeutic effect of complete thyroidectomy on, 173
Antivenin in thrombocytopenic hemorrhage, 285
Apparatus to lift patients suffering from painful conditions (N.I.), 461
Appendicitis, acute, comparative study of leucocyte count and histopathology in, 47
  in children, 397
  chronic-duodenal ulcer, 235
Arterial hypertension, relation of, to surgical risk, 72
Axis, odontoid process of, fracture of (C.R.), 454

Baby, newborn, with massive umbilical hernia (C.R.), 297
Bile, receptacle for collection of, when prolonged drainage is required (N.I.), 126
Biliary system, postoperative visualization of, with radiopaque oils, 383
Biographical Brevities:
  George Emery Goodfellow, 465
  James Douglas, 130
  Oliver Wendell Holmes, 301
Bones, carpal navicular and triquetrum, fractures of, 214
Book Reviews:
  American and Canadian hospitals (Field), 139
  Arteriosclerosis (Cowdry), 305
  Bruchoperation nach Bassini (Catterina), 305
  Cardiovascular pain as a biochemical problem (Lambert), 469
  Collected papers of Mayo Clinic and Mayo Foundation (Mellish-Wilson and Hewitt), 306
  Companion to manuals of practical anatomy (Jamieson), 140
  Control of football injuries (Stevens and Phelps), 306
  Diseases of infancy and childhood (Holt and Howland), 304
  Fractures (Magnuson), 469
  Hirnchirurgie Erfahrungen und Resultate (Hoff and Shonbauer), 306
  History of urology (Ballenger et al.), 142
  Inherited abnormalities of skin and its appendages (Cockayne), 142
  International clinics (Hamman), 140
  Intracranial tumors (Bailey), 139
  Light therapy (Krusen), 139
  Medicine in Canada (Howell), 469
  Nervous child at school (Cameron), 139
  Nontraumatic surgery (Moise), 139
  Nutrition (Lusk), 469
  Obstetrics and gynecology (Curtis), 304
  Operative story of cleft palate (Dorrance), 306
  Operative surgery (Bickham and Smyth), 140
  Operative surgery (Miles), 142
  Operative surgery, abdomen and rectum (Kirschner), 469
  Orthopaedic surgery (Mercer), 141
  Précis d'anatomie pathologique (Roussy, Leroux and Oberling), 305
  Principles and practice of otology (Watkin-Thomas and Yates), 304
  Principles of treatment of muscles and joints by graduated muscular contractions (Smart), 141
  Rise of preventive medicine (Newman), 140
  Roentgenographic studies of urinary system (Lower and Nichols), 141
  Short practice of surgery (Bailey and Love), 142
  Surgery of stomach and duodenum (Horsley), 305
  Surgical anatomy (Callander), 305
  Surgical operations (Groves), 141
  Surgical pathology (Boyd), 141
  Textbook of neuropathology (Weil), 469
  Vorbeugung und Bekampfung der Operationsgefahren (Kappis), 305
Books Received, 470
Bookshelf Browsing:
  Cave man exercise, 466
  Evolution of herniorrhaphy, 131
  Sir Robert Jones and Mr. Owen Thomas, 302

Cancer, rectal radiation therapy of, 78
Carcinoma, follicular cell, of ovary, 97
Carpal navicular and triquetrum bones, fractures of, 214
Case Reports:
  Fracture of odontoid process of axis, 454
  Gastro-pleuro-cutaneous fistula following gunshot wound, 458
  Needles in deep urethra; stone and periurethral abscess, 452
  Newborn baby with massive umbilical hernia, 297
  Repeat of rare congenital malformation of intestine, 294
Cave man exercise (B.B.), 466
Childhood, gastrojejunal ulcer in, 240
Children, appendicitis in, 397
  and infants, hemipyonephrosis in, treatment by heminephrectomy, 85
  young, gall-bladder disease in, 43
Colon, fibroma of, 82
Complications, postoperative pulmonary, report of, 428
Congenital malformation of intestine, rare, repeat of, (C.R.), 294

Diagnosis of perforated peptic ulcer, value of radiology in, 392
Disease, chronic thyroid, one continuous disease process, 446
Dispensary and office, treatment of minor infections in, 358
Distention, postoperative, effect of foods on, 184
Douglas, James (Bi.B.), 130
Duodenal ulcer—chronic appendicitis, 235
Duodenitis, 368

Editorial:
  Memoranda, 299
  Message to radiologists, 463
  Traumatic surgery of future, 127
Empyema, acute, treatment of, 289
Encephalographic studies in epileptiform seizures, 431
Entodermal tumors, sex incidence of, 438
Epileptiform seizures, encephalographic studies in, 431
Evolution of herniorrhaphy (B.B.), 131
Exercise, cave man (B.B.), 466

Femur, fractures of, 21
Fibroma of colon, 82

Fistula, gastro-pleuro-cutaneous, following gunshot wound (C.R.), 458
renocolic, 242
Follicular cell carcinoma of ovary, 97
Foods, effect of, on posteroperative distention, 184
Fracture(s) of carpal navicular and triquetrum bones, 214
of femur, 21
of head of tibia involving knee joint, new method of reducing, 230
of odontoid process of axis (C.R.), 454
of patella, closed method of reduction of, 28
Future, traumatic surgery of (E.), 127

Gall-bladder disease in young children, 43
operations, review of 347, 30
Gall bladder, papilloma of, 38
Ganglionectomy, sympathetic, in cases of postencephalitic parkinsonian syndrome, observations following, 411
Gangrene, scrotal, following closed operation for hydrocele, 418
Gastrojejunal ulcer in childhood, 240
Gastro-pleuro-cutaneous fistula following gunshot wound (C.R.), 458
Gonococcal laparotomy wound infection, 123
Goodfellow, George Emery (Bi.B.), 465
Gunshot wound, gastro-pleuro-cutaneous fistula following (C.R.), 458

Hand injuries, tendons in, consideration of, 354
Head injuries, management of, 403
psychoneuroses secondary to, 210
Heart failure, congestive, and angina pectoris, therapeutic effect of complete thyroidectomy on, 173
Heminephrectomy, treatment by, in hemipyonephrosis in infants and children, 85
Hemipyonephrosis in infants and children: treatment by heminephrectomy, 85
Hemogram, Schilling, value of, in infections, 56
Hemorrhage, thrombocytopenic, antivenin in, 285
Hereditary agenitalism, 104
Hernia, umbilical, massive, newborn baby with (C.R.), 297
ventral, new technique in its repair, 116
Herniorrhaphy, evolution of (B.B.), 131
Histopathology and leucocyte count, comparative study of, in acute appendicitis, 47
Holmes, Oliver Wendell (Bi.B.), 301
Hormones, ovulation, menstruation and, 272
Hydrocele, closed operation for, scrotal gangrene following, 418
Hypertension, arterial, relation of, to surgical risk, 72

Infants and children, hemipyonephrosis in, treatment by heminephrectomy, 85
Infection(s), gonococcal laparotomy wound, 123
minor, treatment of, in dispensary and office, 358
value of Schilling hemogram in, 56
Injection treatment of varicose veins, sodium morrhuate in, 408
Injuries, hand, tendons in, consideration of, 354
head, management of, 403
psychoneuroses secondary to, 210
Insemination, physiologic artificial, 450
Intestinal obstruction, acute, 143, 307, 471
Intestine, rare congenital malformation of, repeat of (C.R.), 294

Jones, Sir Robert, and Mr. Owen Thomas (B.B.), 302

Knee joint, new method of reducing fractures of head of tibia involving, 230

Laparotomy wound infection, gonococcal, 123
Leg, varicose ulcer of, 406
Leucocyte count and histopathology, comparative study of, in acute appendicitis, 47

Malformation of intestine, rare congenital, repeat of (C.R.), 294
Management of abruptio placentae, 279
of head injuries, 403
Maximum urea clearance, 247
Menstruation, ovulation and hormones, 272
Minor infections, treatment of, in dispensary and office, 358
Myositis ossificans progressiva: clinical notes and roentgen findings, 111

Navicular, carpal, and triquetrum bones, fractures of, 214
Needles in deep urethra; stone and periurethral abscess (C.R.), 452
Nervous system, sympathetic, surgery of, 345
New Instruments:
Apparatus to lift patients suffering from painful conditions, 461
Receptacle for collection of bile when prolonged drainage is required, 126
Newborn baby with massive umbilical hernia (C.R.), 297

Obstruction, acute intestinal, 143, 307, 471
pyloric, roentgenologic study, 376
Odontoid process of axis, fracture of (C.R.), 454
Office, dispensary and, treatment of minor infections in, 358
Olecranon, osteochondritis deformans juvenalis of, 227
Operations, gall-bladder, review of 347, 30
Osteochondritis deformans juvenalis of olecranon, 227
Ovary, follicular cell carcinoma of, 97
Ovulation, menstruation and hormones, 272

Pain, paralgesia: paravertebral block for relief of, 416
Painful conditions, apparatus to lift patients suffering from (N.I.), 461
Pancreas, surgical exposure of, 390
Papilloma of gall bladder, 38
Paralgesia: paravertebral block for relief of pain, 416
Paravertebral block for relief of pain, 416
Parkinsonian syndrome, postencephalitic, observations following sympathetic ganglionectomy in cases of, 411
Patella, fracture of, closed method of reduction of, 28
Peptic ulcer, perforated, value of radiology in diagnosis of, 392
traumatic, 12
and venofibrosis, 180
Physiologic artificial insemination, 450
Physiopathology and treatment of thromboangiitis obliterans, newer concepts on, 260
Pilonidal sinus, observations on treatment of, 120
Postencephalitic parkinsonian syndrome, observations following sympathetic ganglionectomy in cases of, 411
Postoperative distention, effect of foods on, 184
pulmonary complications, report of, 428
visualization of biliary system with radiopaque oils, 383
Prostatic resection, transurethral: technique and results in 205 cases, 421

Psychoneuroses secondary to head injuries, 210
Pulmonary complications, postoperative, report of, 428
Pyloric obstruction: roentgenologic study, 376

Radiation therapy of rectal cancer, 78
Radiologists, message to (E.), 463
Radiology, value of, in diagnosis of perforated peptic ulcer, 392
Radiopaque oils, postoperative visualization of biliary system with, 383
Receptacle for collection of bile when prolonged drainage is required (N.I.), 126
Rectal cancer, radiation therapy of, 78
Renocolic fistulae, 242
Resection, transurethral prostatic: technique and results in 205 cases, 421
Risk, surgical, relation of arterial hypertension to, 72
Roentgen findings and clinical notes in myositis ossificans progressiva, 111
Roentgenologic study: pyloric obstruction, 376

Schilling hemogram, value of, in infections, 56
Scrotal gangrene following closed operation for hydrocele, 418
Sex incidence of entodermal tumors, 438
Sinus, pilonidal, 120
Sodium morrhuate in injection treatment of varicose veins, 408
Spine, tuberculosis of, 204
Stomach, syphilis of, 1
Surgery of sympathetic nervous system, 345
  traumatic, of future (E.), 127
Surgical exposure of pancreas, 390
  risk, relation of arterial hypertension to, 72
Sympathetic ganglionectomy in cases of postencephalitic parkinsonian syndrome, observations following, 411
  nervous system, surgery of, 345
Syphilis of stomach, 1

Tendons in hand injuries, consideration of, 354
Therapeutic effect of complete thyroidectomy on congestive heart failure and angina pectoris, 173
Thomas, Mr. Owen, and Sir Robert Jones (B.B.), 302
Thromboangiitis obliterans, newer concepts on physiopathology and treatment of, 260
Thrombocytopenic hemorrhage, antivenin in, 285
Thyroid disease, chronic, one continuous disease process, 446
Thyroidectomy, complete, therapeutic effect of, on congestive heart failure and angina pectoris, 173
Tibia, fractures of head of, involving knee joint, new method of reducing, 230
Transurethral prostatic resection: technique and results in 205 cases, 421
Traumatic peptic ulcer, 12
  surgery of future (E.), 127
Treatment of acute empyema, 289
  of minor infections in dispensary and office, 358
  and physiopathology of thromboangiitis obliterans, newer concepts on, 260
Triquetrum and carpal navicular bones, fractures of, 214
Tuberculosis of spine, 204
Tumors, entodermal, sex incidence of, 438

Ulcer, duodenal—chronic appendicitis, 235
  gastrojejunal, in childhood, 240
  perforated peptic, value of radiology in diagnosis of, 392
  traumatic peptic, 12
  varicose, of leg, 406
Umbilical hernia, massive, newborn baby with (C.R.), 297
Urea clearance, maximum, 247
Urethra, deep, needles in; stone and periurethral abscess (C.R.), 452

Varicose ulcer of leg, 406
  veins, sodium morrhuate in injection treatment of, 408
Venofibrosis, peptic ulcer and, 180
Ventral hernia, new technique in its repair, 116
Visualization, postoperative, of biliary system with radiopaque oils, 383

Wound(s) of abdomen, penetrating, 17
  gunshot, gastro-pleuro-cutaneous fistula following (C.R.), 458
  infection, gonococcal laparotomy, 123